(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

140 NASSAU STREET, NEW YORK

J. S. BONSALL,
Business Manager.

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

AUGUST, 1908

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The action of the American Railway Association at its April meeting, in adopting resolutions concerning the co-operation and harmonizing of the work of the various voluntary railway associations practically amounts to giving the findings and recommendations of such bodies a much greater value and importance than they have heretofore assumed. If the spirit of the resolution is fully carried out it will mean that any recommendations of any one of the 33 associations listed, which appears in print with the authority of that association, can be assumed to carry official sanction. This will act in raising the grade of many of these associations which have heretofore been chiefly educational or social in their character and will put them in a position of greater importance and usefulness, both to their own members and to the railroad companies. Incidentally it will also greatly reduce the opportunity of their causing any great damage by ill advised recommendations of some member or committee who may not be fully conversant with all phases of his subject.

As far as the Master Mechanics' and Master Car Builders' Associations are concerned, this action will have but little effect as they have both always worked in co-operation with the American Railway Association to a very large extent.

MOTOR CARS.

The self-contained motor car for railway use has been a very attractive subject of discussion and experiment for a good many years and taken together there has been quite a large number of these cars built in this country and even more on foreign railroads. These have, with comparatively few exceptions, proved to be failures for one reason or another. Most of them have been more or less successful from a mechanical standpoint, but have failed in various ways as an operating proposition.

In general, motor cars can be divided into three practical types, each of which has its own inherent advantages and disadvantages. These are the gasolene type, the gas-electric type and the steam type. They all, however, have one common disadvantage in the fact that the motive power and the car body are practically inseparable and it is impossible to care for the former in the same place and manner as other motive power on the road is cared for. It is also necessary to put the whole car out of commission whenever the motive power needs attention. Even at the best these cars are expensive and if the service is to be handled satisfactorily with them it will always be necessary to have an extra unit or so for use in cases of emergency, which will make the capital charge of the equipment for this service comparatively heavy.

It is difficult to understand what there is about the light traffic of a branch line that cannot be handled by a small, highly specialized locomotive, preferably of the 0-4-0 tank type, attached to a combination passenger and baggage coach, fully as well as by a self-contained and propelled motor car. Such an arrangement has many advantages both in respect to the original cost of the equipment and the maintenance charges. In this connection it is instructive to note that the Bavarian State Railways, which have for several years been operating steam motor cars and have over thirty in service, have decided to discontinue building this type of equipment and have designed a small, but very powerful, four-wheel tank locomotive which can be coupled to a light passenger car and perform the service with equal satisfaction. This arrangement simply amounts to separating the motive power from the passenger compartment of a steam motor car and permits the former being taken care of in the regular engine house. It also provides equally good service with a smaller capital expenditure and gives a greater flexibility to the train capacity.

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MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACT OF COMMITTEE REPORTS.—(CONTINUED FROM PAGE 271.)

Ventilating and Heating of Coaches and Sleeping Cars.

Committee—S. G. Thomson, chairman; B. P. Flory, T. H. Goodnow.

The work as assigned to the committee on the ventilating and heating of coaches and sleeping cars was: "To investigate methods for the regulation of the temperature and the supply of fresh air to passenger cars, with special attention to sleeping cars, and to recommend plans which provide for the regulation of the heat and the air supply by the occupant of each berth."

The principles involved in this subject are so broad, the variations of the conditions so great, and the state of the art so undeveloped, that the committee considered it best to limit its investigation and suggestions to general lines, and not to include any more detail than was necessary to illustrate some of the important principles, and to describe a few of the best methods in use.

Special effort was made to obtain information from the Pullman Company concerning its ventilating experience and plans for betterments, as well as to have one of its representatives present at a committee meeting; but the Pullman Company did not have anything to present. For this reason the conclusions and recommendations as given in this report, concerning the Pullman equipment, are not based on any definite information or data that have actually been obtained, but rather are formulated from the views of the various railroad officers as expressed in their communications and from the personal views of the committee.

The information which the committee was able to obtain failed to reveal any variety of thoroughly successful ventilating systems which have been extensively tried out, or new devices which are being developed; and the work as outlined seemed to resolve itself into a question of collecting information concerning the few older systems and devices that have been in use, and of developing arguments and ideas concerning new methods, such as any one might wish to propose.

About forty years or more ago, Professor W. Ripley Nichols, of the Massachusetts Institute of Technology, made some investigations of a system in use at that time known as the Winchell Ventilating System. This system was arranged so that air was admitted to the car at the end under the front hood, then allowed to distribute as it would through the car, and to pass out under the rear hood, without any attempt being made to warm it as it entered. Professor Nichols determined that 7,000 to 10,000 cubic feet of air per hour was furnished under favorable conditions. Later experiments with this system at Altoona indicated that 15,000 to 25,000 cubic feet of air per hour was furnished, depending on conditions. It was also found that the movement of air in the car was hardly perceptible when the car was standing still, there being even less air movement with the large openings than is found in many of our more tightly closed modern coaches.

The next type of ventilating system was that found in the early type passenger coaches, known as the Spear Stove System. It consisted of hoods or intakes at diagonal corners of the car, which intakes were connected with the coal stove. The movement of the car forced the air down around the stove and into a box running the length of the car along each side above the floor. From this boxing or duct the warmed air was admitted into the car through various openings in the side of the duct. It then ascended through the body of the car and passed out through the deck sash. This system was a great improvement over any that had thus far been tried, but it was still subject to the following defects: When the car was not moving, the current of warm air was reversed and passed from the car out through the intake. Another trouble was, that the proportion of exits and intakes was not such as to give a balance of pressure between the inside and the outside of the car, and the exits were so much in excess of the intakes that cold air in the winter time would be drawn in around the windows and through every crevice. The trailing deck sash gave rise to various cross-currents, since it was often found that air would enter the car through the deck sash instead of going out, as it should. These cross-currents, in the upper deck interfered with the proper burning of the lamps, and did not change the air to any extent as low down in the body of the car as the breathing line. The deck sash also admitted cold draughts, cinders and smoke overhead, to such an extent as to be very annoying. The construction of the deck sash had not been brought up to the higher state of development in which we find it in use to-day on some of the most improved equipment.

The Spear Stove System was modified later by removing the stoves and by substituting for them steam radiator pipes extending the length of the car in the air duct, and by adding ventilators on the upper deck of the car roof. This was an improvement, in that it eliminated the stove and gave an exit for air, other than the deck sash. With some slight modifications, such as the adding of extra radiators at the ends of the car, just inside the doors, this was the type of ventilating system that immediately preceded the modern indirect systems now in use.

The deck sash system, which is now very generally used, was evolved from various former arrangements of deck sash, and its construction has been improved so as to eliminate many of the objectionable features of the former arrangements. The use of wire netting outside of the sash has largely eliminated dirt and cinder entering. This deck sash method of ventilation necessarily separates the heating and ventilating systems, and does not warm the air before it comes into the car. No special air intakes are provided, except the deck sash, and the change of air in the car is limited to the amount that will pass in and out through these openings. When the deck sash is thrown open in the winter time, it very quickly relieves an overheated car, as some of the cold entering air drops into the body of the car to take the place of the heated and vitiated air. This momentary dropping of cold air is effective in relieving a stuffy and overheated car, but continuous draughts created in this way are very objectionable to passengers in cold weather. In the summer time, this dropping of the cool currents is not so pronounced, and the movement of air is not sufficient for good ventilation. This system has been used in the Pullman cars for a long time, but it is now being modified by the application of a late type of the Garland ventilator to the deck sash. This ventilator has eliminated the objectionable down-draughts by creating a strong exhaust, and thus directing all the currents upward and outward through the roof.

The present standard ventilating arrangement of the Pennsylvania R. R. was started in its development more than ten years ago, and is the result of a number of years of study and experimental work. A large number of tests were made, resulting in modifications and changes, each change being followed by runs on the road, and by analyses of air taken from the cars under various conditions. The arrangement, as thus developed, has been gradually applied to cars, until it is now in service on more than one thousand coaches. The system admits the air through hoods located on diagonal corners of the car. The air passes down a vertical boxing to a horizontal duct under the floor, which duct runs the length of the car between the side and the adjacent intermediate sills. Then the air ascends through slots in the floor to a longitudinal boxing or duct containing steam pipes, extending along the sides of the car, above the floor and immediately over the air duct, thence through galvanized iron tubular pipes under each seat to the aisle, where it ascends and passes out through globe ventilators located over the lamps along the center line of the upper deck.

The system is designed to furnish one thousand cubic feet of fresh air per hour per person, while working normally on a moving train. This figure was based on there being 60 passengers to the car, which would require 60,000 cubic feet of air per car per hour, a complete change of air in the car fifteen times per hour, or once every four minutes. That this amount of air is furnished by the ventilating arrangement, has been proven by numerous tests which were made during its development. Samples of air were taken under various conditions from cars filled with workmen, while the train was running at speed with all the ventilators open; also, while the train was running with all the ventilators closed, as well as while it was standing still with all the ventilators open. The analyses were made by a test for carbonic acid in the air, and the calculations were made by determining the amount of fresh air that it would take to dilute the estimated amount of carbonic acid exhaled by the number of men in the car, so that the air in the car would equal in carbonic acid the amount that was actually found to exist in the samples taken. A representative test made in the winter time under normal conditions, showed by this method of calculation that 62,400 cubic feet of air per car per hour was furnished, while the train was running about 30 miles per hour with all the ventilators open; 27,000 to 37,000 cubic feet of air was furnished while running with all the ventilators closed, and about 23,000 cubic feet while the train was standing with the ventilators open.

The operation of the system is not entirely dependent on the movement of the car; since, when the car is standing still, the normal circulation of air is maintained by the rising heated cur-

rents, when there is heat or light in the car. This natural rising of the warm currents will furnish, under favorable conditions, about one-third of the change of air necessary for a crowded car. When a car is standing at a terminal and there is neither heat nor light in it, which is usually in the summer time, the proper ventilation is not furnished through the ventilating system, but is obtained by keeping the windows and doors open as much as possible.

As a whole, the system is efficient in almost every way when the train is running, but when the train is standing still, the system itself does not provide for any better ventilation than is afforded by the ordinary deck sash arrangement. This can clearly be seen in a smoking car: first, by observing the accumulation of smoke and the stillness of the air when the car is standing at the station awaiting departure with the doors open, and then, after the train starts and the doors are closed, by watching the gradual disappearance of the heavily laden air until the train has attained its speed; at which time the air in the car has become fresh and the car is almost cleared of smoke.

The conditions that prevail while a train is standing still are so quickly relieved after it gets into motion that the insufficient amount of ventilation supplied in the former case is comparatively of minor importance. This means that, in any system of day coach ventilation, we have first to consider the condition in which the passengers are kept enclosed for hours at a time during a long trip, and then, after this is made satisfactory, to take care of the local terminal conditions in whatever way seems advisable and in accordance with the necessity. This terminal condition is of more vital concern in the case of sleeping cars which may be in such service as require them to stand in a station during the night for a number of hours before the departure or after the arrival of a train. The only way to solve this difficulty will be to install a forced-draught system on a few cars that could be assigned exclusively to such service as was thought to warrant the extra expense. This would involve the installation of fans, ducts and registers, arranged according to the type of car.

The Pullman ventilating system will be recognized as the direct opposite to the Pennsylvania arrangement, in that the heating and the ventilating systems are separate, and the air is not heated before it enters the car. This deck sash arrangement is used almost universally all over the country, in day coaches as well as in the sleeping cars. Many roads are using the earlier type of drop and trailing deck sash, while others have improved their conditions somewhat by introducing special ventilators, either in place of or in connection with the deck sash, or on top of the upper deck. There has been a tendency during the last few years to use various types of ventilators in the upper deck which induce strong exhaust currents from the car, without providing any intake. This has considerably changed the ventilating conditions in cars equipped with the deck sash system. The former theory was to allow fresh air to enter from above and to drop to the breathing line, while the latter theory is to create a sufficiently strong exhaust from the upper deck to keep the currents always moving upward, and to draw out the vitiated air in sufficient quantities to keep the car well ventilated, allowing the supply to come from wherever it will.

The strong exhaust principle has not been in use a sufficient length of time on coaches and Pullman cars to allow any definite conclusions to be reached in this report concerning its general application to existing equipment; but several ideas occur in this connection which may be worthy of mention. The fact that no special intakes are provided to supply the large amount of air that should be furnished for good ventilation makes it necessary that this quantity of air must be drawn either from the ends of the cars, or in through the cracks around the windows, or down the lamp jacks, if such happen to be open into the body of the car. This condition would be most objectionable in a day coach, as the admission of air through the lamp jacks would interfere with the proper burning of the lights, and it would not change the air to any extent in the lower part of the car near the floor. On the other hand, an admission of any such quantity of air as 60,000 cubic feet per hour through the cracks around the windows and doors, would, if it could be accomplished, create intolerable draughts, and would make the occupation of the seat next to the window very undesirable in cold weather. These strong exhaust ventilators applied to a day coach with its single windows will always set up excessive draughts, even if very much less air is being drawn through the car than is required for good ventilation, and the result necessarily will be a condition of insufficient ventilation, and an excessively draughty car. The question of providing inlets to relieve the window draughts without changing to the indirect system of heating is a difficult matter, for the reason that any admission of untempered air at or near the floor would be just as objectionable as the window draughts, if not more so, since a cold floor is most certainly to be avoided. The strong exhaust principle should not be used as the only means of ventilation in building new coaches or Pullman cars, and should not be carried too far in applying it to existing equipment, without also providing an adequate intake of fresh, warmed air. If the heating system is not modified in the application of the exhaust ventilator to the present equipment, the strong, cold draughts are apt to be more of an objection than the additional amount of air movement is to be an advantage.

The exhaust ventilator with a strong draught, when applied to the Pullman car, has to meet a different condition and has a different effect than when applied to the day coach; since the Pullman cars are more tightly constructed than the coach, and they do not need as much air for good ventilation, on account of the correspondingly smaller number of passengers that can occupy them. The window draughts are reduced to a minimum by the double sash, and the ends of the cars are tightly enclosed. A strong exhaust ventilator arranged to draw from such an enclosed space seems to be a great opposition of forces. Under such conditions, the amount of change of air and the capacity of the ventilators necessarily depends on the amount of air that can be drawn from the ends of the car and through the openings at the windows. Such a partial vacuum created in the car body will doubtless cause a movement of air from the point of least resistance and thus cause an excessive draught at an open window screen or ventilator or vestibule door. In a Pullman car, the point of least resistance to incoming air, when there are no screens in the windows, is apt to be at the ends of the car, and in this fact there lies a danger, since the odors from the smoking room and saloons are liable to be drawn into the body of the car. This only could be prevented by the use of ventilators having a force exhausting directly from these end compartments, greater than the force due to the combined action of all the ventilators in the body of the car. This feature is a more serious consideration in the day coach than in the Pullman car, since the saloons are not so much isolated from the body of the car, and since the additional end door leakage, and the increased opening and closing of the doors by trainmen, are more apt to cause the movement of air to be toward the middle of the car, than from the middle toward the ends. This objectionable movement of air can be controlled by the use of properly located and correctly proportioned ventilators, and the feature is only mentioned as one to be avoided.

The relation of the strong exhaust ventilator to the heating and ventilating of the Pullman car is a difficult matter to analyze; since the conditions to be met, especially in a sleeping car with the berths made up, are necessarily very complicated. The principal trouble with the sleeping car in the winter time, when the train is moving, has always been to avoid an excess of heat and a lack of ventilation in the lower berths, and a lack of heat and an excess of ventilation in the upper berths. In the summer time, the ventilation of the lower berth is improved somewhat by the use of the window screens, and most of the complaint is due to the conditions when a car is standing at a terminal. The application of the exhaust ventilator to a sleeping car not having special air intakes will not be very effective in relieving the overheated condition of the lower berth in cold weather; but it should improve the heating of the upper berth by drawing a greater proportion of the heat up along the windows and around the upper berth inside the curtains, instead of allowing the most of it to be absorbed in the lower berth, and to pass outside the curtains to the cold aisle and thus escape through the ventilators. The exhaust ventilator also prevents cold draughts from entering the deck sash, which draughts are often so objectionable in the upper berths, and in doing this it should further facilitate the heating, and at the same time it should diminish the excessive ventilation of the upper berth. The ventilation of the lower berths is doubtless improved to some extent by the increased air movement induced behind the curtains by strong exhaust ventilators in the upper deck. This ventilation might be still further improved by connecting a portion of the ventilator to a duct extending down through the walls of the car to the lower berth. It is the opinion of your committee that, as a whole, the general conditions of heating and ventilation of the sleeping car have been improved by the introduction of the strong exhaust ventilators.

The Garland ventilator, as now being applied by the Pullman Company, is constructed upon the aspirator principle, and its entire function is to draw the air from the car. The arrangement of the ventilator ducts and the force of the outgoing air largely eliminates the possibility for smoke, cinders and rain to enter the car through the deck, which is a serious objection to the ordinary deck sash arrangement. The addition of the central duct to this ventilator is the latest development in the direction of an increase of its exhausting power. As now constructed it is a simple and efficient exhausting arrangement and a further description in detail is unnecessary. It is thought that a partial vacuum in the car could be created to almost any degree that might seem desirable, by a sufficient application of a device of this sort; but this partial vacuum, in any other than a Pullman car, will in all probability prove to be more of a harm than a benefit. In a sleeping car at night, a strong exhaust seems to be an advantage and may prove to be a necessity as an assistance to an indirect heating and ventilating system.

The Central Railroad of New Jersey uses a ventilating system, which is a modification of the purely exhaust methods as used

by the Pullman Company, in that an air intake as well as an exhaust, is provided by a combination ventilator. This ventilator has been in operation above five years on the above railroad, where it has been developed in connection with the Automatic Ventilator Company. This latter company has patents controlling the use of this device.

This ventilator is arranged to be substituted for the regular deck sash; or, in cases where it is desired to have an opalescent or other decorative inside sash as a part of the interior finishing of the car, the ventilator can be arranged outside of the sash, and so constructed that the opening of the deck sash will open the ventilator. The device also can be arranged to extend through the car roof, and may be adapted to a car with any design of upper deck. The general arrangement of it is always the same, and consists of two openings or ducts extending into the car, each about 4 by 6 inches in size, with a deflector located between them and extending outwardly at right angles to the panel through which the ducts pass. The proper shutters, screens and other details are provided for controlling the device, and for the exclusion of dirt, cinders and rain. The end of the deflector is bent so as to scoop the air into the forward duct and to exhaust it from the rear duct. Some of the tests show that about 100 cubic feet of air per minute enters the intake side of one ventilator and 116 cubic feet is drawn out of the exhaust side, while running at speed. Tests are now being made to determine the extent that the air is changed in the lower part of the car. A considerable difference in temperature between the outgoing and the incoming air, as has been shown by the numerous tests already made, would seem to indicate that an effective circulation is maintained down through the body of the car. A panel ventilator of this kind has been constructed to take the place of a screen in the lower berth of a sleeping car, the thought being that the occupant could manipulate it to admit air to the berth, or to exhaust it from the berth, as he might desire.

The report has thus far included a description of three distinct systems or principles of car ventilation. The first one is a balanced intake and exhaust system in which the air is warmed before it enters, and must pass through the body of the car before it is exhausted. The second is either a combination admission and exhaust deck-sash arrangement, or, in its later developments, is strictly an exhaust system without any special intakes, in which case the air enters wherever it can and is drawn to the upper deck from all parts of the car. The third system is a combination admission and exhaust arrangement located in the upper deck, with a special ventilator arranged to force and to regulate the air circulation. The first system involves the indirect method of heating, while in the other two arrangements the air is heated by radiators after it is in the car. All other arrangement in use are modifications or combinations of these principles, except the forced-draught or fan system.

The principal argument in favor of the direct method of heating is that fresh, cold air directly from the outside is more invigorating than it is after the life is taken out of it by passing it over heating pipes. Another argument is that passengers desire to see the deck sash open, and that this in itself makes them think they are getting good ventilation. While there may be some weight to the latter argument, they both seem to be misleading in not making a distinction between the heating and the ventilating of a car. Heating does not mean ventilation, nor does ventilation mean heating; since a stifling hot car may be well ventilated, and since a car kept at exactly the proper temperature may not have any ventilation at all. Most of the complaints made by the traveling public are the results of an improper heating of the cars rather than an insufficient change of air in them; not that the ventilation is less at fault than the heating of the car, but because differences in temperature are much more easily and quickly felt than is a lack of ventilation. A passenger can stand a little cold air for a few minutes, as when relieving an overheated car; but when a considerable amount of air is required continuously for any length of time in order to provide the necessary change of air for good ventilation, the committee believes that it must be warmed before it is introduced into the car by some kind of an indirect heating system.

It is the opinion of the committee that, for a given amount of air movement through a car, this air can be heated more satisfactorily and with less steam by the indirect method, than it can by the direct method, on account of a better circulation being maintained around the steam pipes by the indirect system; therefore, it would recommend that the indirect method of heating be used for all new equipment, and for such present equipment as it is practicable to change from the direct to the indirect system. For such coach equipment as it is not expedient to change to the indirect system of ventilation, the committee suggests that extended experiments be made with combination admission and exhaust ventilators located in the upper deck.

Many authorities on ventilation claim that the down-draught system is the only one that should be used for buildings, while others state that the warm air should be admitted near the floor through as many openings as possible, and taken out at the ceiling. An argument in favor of the down-draught system is: that carbonic acid (CO_2), being heavier than air, falls as it is exhaled; also that the breath is exhaled in a downward direction, which assists the falling tendency, and therefore the carbonic acid should be taken out at or near the floor. Another argument is, that the only way to prevent perceptible air currents, is to introduce warm air overhead and allow it to spread uniformly under the ceiling and then to diffuse equally all through the room, rather than to introduce it at the floor and allow it to rise to the breathing line in currents which carry with them dust and microbes from the floor. It is hardly probable that the carbonic acid as exhaled is sufficiently heavy to cause it to fall, since it is usually at 10 to 15 degrees higher temperature than the surrounding air, nor would the addition of about 4 parts of carbonic acid to 10,000 parts of air be likely to counteract the rising tendency of the comparatively large body of air with which it was mixed. However, while this is entirely theoretical, it is the possibilities of actual application that govern, and on this account it is doubtful if the down-draught system could be applied satisfactorily to any type of passenger car. The committee does not recommend the down-draught system of ventilation for any kind of passenger equipment.

It is generally conceded that a forced-draught system is not necessary for the usual equipment in regular service. With reference to special service equipment, such as dining cars, private cars, and certain sleeping cars, the committee believes that a proper forced draught or blower system is, in some cases, necessary and very desirable, as an addition to the regular methods of ventilating these cars. A sleeping car that stands at a terminal in the summer time from 9 P. M. until after midnight to receive passengers, should certainly have some auxiliary means for forcing ventilation, which could be used until the car leaves on its trip. It should be possible to keep a few cars in this kind of service, and to equip them with a blower or an exhaust fan system that could be used in connection with the ducts of the regular indirect heating and ventilating system of the car. These ducts should lead to each lower berth, and the system might be arranged, either to blow fresh air into the berth or to exhaust the vitiated air from it. The committee does not believe that the fan or blower system would be warranted for all regular equipment, since it would be too expensive to install, and since it could not be maintained in good condition by the ordinary attention that it would receive from the porters and train crews.

Some claims are made that the dropping window would allow cool, fresh air to be admitted to the car over the heads of the passengers without striking them directly, and that such an arrangement would have somewhat the same good effect as the dropping of a window in a house to allow vitiated or overheated air to pass out. The committee does not believe that this arrangement would be satisfactory for a car window, as, at best, it would be useful only in mild weather, and would be more objectionable than the open deck sash in cold weather. The incoming cold draught might not strike the person sitting next to the window, but, as it would descend in the car, it would be very objectionable to the passengers sitting farther back. A constant opening at the upper part of the window would be too low to give much relief to an overheated car, and it would create undesirable draughts and cross-currents around the heads of the passengers in cold weather. In warm weather the passengers wish to have the window entirely open and the sash out of the line of vision; so that, in this respect, it does not make any difference whether the sash is raised or lowered.

Some claims are made that the present screen arrangement in the lower berth is good enough, since in any event the porter would usually be asked to make the necessary adjustments before the passenger would retire. This may be true, but the screen arrangement does not allow the occupant to close the window during the night if the berth becomes too cold, or to have a screen inserted if the berth becomes too warm. An easily operated window would place the ventilation of each berth in the control of the occupant.

Various arrangements for window ventilation might be applied. A rolling screen might be attached to the window so that it would close and open with the window. Another arrangement would be to place the regular screen under one sash, and to have the other sash balanced and the fixtures so arranged that it could be opened or closed to whatever extent the occupant of the berth might desire. Another means of ventilation, and one which would not require the use of a balanced sash, would be to use, instead of the usual screen, a ventilating panel of the "Automatic Ventilator" type, having screened openings which could be used to admit or to exhaust air, and which could be opened or closed at the discretion of the occupant of the berth. A proper manipulation of such a device should give better results than do the plain screen openings as now used. Very fine screens would necessarily have to be used on the intake side of such a ventilating panel, on account of the extra movement of air into the berth, which would tend to bring in with it an additional amount of cinders and dust. Still another method for ventilating the lower berth would be to extend a short duct through the walls of the car from each lower berth to a venti-

lator on the roof or under the car located in such a way that one ventilator would be provided for each lower berth or for each two adjacent berths. The openings into the berths might have a register or shutter which could be operated by the occupant, and the ventilators and ducts could be constructed to admit or to exhaust the air or possibly to do both.

The committee recommends that experiments be made with the view of ventilating the lower berth of the sleeping cars, either by means of a balanced window, a ventilating panel, or by a series of ducts and ventilators; such devices to be in addition to the regular heating and ventilating system of the car, and to be used at night when the berths are made up. It further recommends that extended experiment be made with these window and auxiliary arrangements in combination with the strong exhaust ventilators as now used.

The committee believes that it is altogether practical to modify the present sleeping car equipment in such a way as to provide, under the ends of each lower berth, an opening for fresh air that can be controlled by the occupant. Such an arrangement might require some additional radiator pipes, and it might prove desirable to carry a branch of the heating duct to the aisle between each berth and the pillow boxes, in order to admit the warm air to the body of the car in the day time. These ducts could have registers in the ends of them, which should be closed at night, since it would not be desirable to lead warm air to the aisle, only to be wasted through the ventilators in the upper deck. The closing of these branch registers at night and the regulating of the registers under the berths by the occupants, would allow all the heat to be retained in the heating system and to be sent along and delivered to the various berths as might be desired. Your committee realizes the difficulties that might be experienced with any ventilating and heating system, in which the exits and entrances for air are thus allowed to be opened and closed promiscuously. However, it does not seem that this opening and closing of the places of admission would alter, to any great extent, the total amount of air that would pass through the car, but would simply facilitate the distribution of it to the parts of the car where it was most desired. It seems, then, that the fundamental requirement for a sleeping car with the berths made up, is an opening under the lower berth for freshly warmed air in the winter and for cool air in the summer, located in such a way as to allow a distinct movement of air and good ventilation behind the berth curtains. Such openings under the berth for fresh air, even without any means of manipulating them by the occupant of the berth, should give much better results than does the present ventilating arrangement of the sleeping car.

The committee recommends that extended experiments be made, with the view to modifying the existing sleeping car equipment, so as to provide openings under each end of the lower berth; these openings to be controlled by the occupants of the berth, and to be used to admit warmed air in cold weather and cool, fresh air in moderate weather. For new equipment, it further recommends a similar arrangement built into the car and applied in a substantial way, with all the requirements and accessories of a thoroughly complete indirect heating and ventilating system.

Some claim that there should be as good a ventilating system in light suburban, steam or electric equipment as in any other. The argument is, that these cars usually carry more passengers than any of the other equipment, and therefore, they need as much, if not more, ventilation. This is true as far as the needs of ventilation are concerned; but it is not necessary to provide a large part of this air by the ventilating system, since it is usually furnished by the continued opening and closing of the doors. In such service as does not involve the frequent throwing open of the doors for the exit and entrance of passengers, which is often the case in the winter, on certain suburban railways, the car should have a thoroughly efficient indirect heating and ventilating system, the same as other equipment in long distance service.

A well ventilated space, according to the best authorities, is one that may be entered by a person from the outside, without the person being able to detect any of that odor which is characteristic of badly ventilated spaces. There is always a certain small proportion of carbonic acid in any outside air, which many tests have shown to be between 3 and 4 parts in 10,000 parts of air; and it has been found by careful analysis, that it is just possible to detect the characteristic odor mentioned, when the natural 4 parts of carbonic acid in the air has been increased by 2 parts of carbonic acid from human beings. A space, then, is well ventilated when it does not contain more than 6 cubic feet of carbonic acid to 10,000 cubic feet of air. It is thought very undesirable to breathe air containing 7 to 8 parts of carbonic acid, and to be injurious to stay any length of time in a space containing 10 parts of carbonic acid in 10,000 parts of air. In this connection it may be of interest to state that offices often contain 8 parts of carbonic acid, crowded opera houses and meeting halls, 14 to 18 parts, and crowded street cars as high as 22 to 23 parts of carbonic acid in 10,000 parts of air. The tests made by the M. C. B. committee in 1894, show in 10,000 parts of air, 11 to 22 parts of carbonic acid in a sleeping car, 6 to 15 parts in a chair car, and 10 to 21 parts in a suburban coach. These high figures are hardly attained to-day, with the improved ventilating methods and the better attention that these matters now receive.

Tests have proven that the average person, such as rides in our cars, gives off six-tenths of a cubic foot of carbonic acid per hour. Sixty persons in a car would therefore exhale 36 cubic feet of carbonic acid, which amount would require 180,000 cubic feet of fresh air per hour to dilute it so that the air in the car would not contain more than 6 parts of carbonic acid in 10,000 parts of air, the theoretical requirement for good ventilation. This large volume of air equals 3,000 cubic feet of fresh air per person per hour, which amount to the committee seems to be too great to pass through a closed car by any practicable methods.

In solving the car ventilating problem, the amount of air which should pass through a car is usually limited by the amount that can be heated, rather than by the amount as determined by theoretical calculations. The Pennsylvania experiments proved that 90,000 cubic feet of air, or half the theoretical amount, could be passed through the car by the methods used, but that only 60,000 cubic feet of air could be heated properly in zero weather. This amount, therefore, which is equal to 1,000 cubic feet of fresh air per person per hour, or a complete change of air in the car once every four minutes, has been taken as the basis for their system of ventilation. These figures have been accepted by many others as a conservative and very fair basis for good car ventilation; and, since this amount has been found very satisfactory and has stood the test for more than ten years with very little complaint, this figure can be accepted generally as a basis, until a better one is established. At the same time, it may be thought desirable for larger cars and for certain kinds of service, to have a still greater movement of air through the car. This the committee believes can be accomplished with either the direct or indirect systems, by the addition of more hoods or ventilators on the roof and more steam pipes or radiators inside of the car. However, when the good results that have been attained with the present figure are considered, there seems to be a point beyond which it hardly seems necessary to go, both from the standpoint of good ventilation and of economy. It also recommends that a minimum of 1,000 cubic feet of fresh air per person per hour be used as the basis for car ventilation until such a time as another figure can be determined to be a better one.

The carbonic acid test, as mentioned in connection with the Pennsylvania system of ventilating, seems to be about the only accurate way to analyze the various conditions of the air in a passenger car, and the committee recommends the general use of this method.

The best place to admit warm air into a day coach seems from the latest developments to be through pipes, opening at the aisle under each seat. These pipes should connect with a double duct, arranged for distributing and heating the air. The lower duct should provide a free, unrestricted passage for the entering air, so that it is allowed to be distributed along the length of the car at the same time that it is being admitted to the heating duct above it. This allows all the air about an equal contact with the heating pipes, and distributes it effectively throughout the length of the car. If the incoming air was required to travel the length of the car in the duct occupied by the heating pipes, neither the heating of the air nor its distribution in the car would be satisfactory.

The removal of air from the car has been the cause for frequent experiments. Coaches having the indirect system of heating have been fitted up with a large number of ventilators, and also with a comparatively few. It was found with twenty ventilators on a car, that the front ones made more vacuum in the car than could be supplied by the regular intakes at the floor, and that perceptible currents of air were drawn down through the rear ventilators, thus causing the back part of the car to become cold. This difference of temperature at the two ends of the car was eliminated by closing some of the ventilators, which change seemed to prove that the intakes and exits in any system should be very nearly equal in order to obtain the best results.

The committee recommends that the warmed air from an indirect heating system be introduced at or near the floor for all classes of equipment, and be exhausted at the roof at a less rate than it enters; also, for all new equipment, that separate air and heating ducts, with openings between them and to the outside air, be arranged along the length of the car on each side. It also recommends for existing Pullman equipment, that extended tests be made for the purpose of determining the best methods for providing an ample opening for fresh air to enter through a heater box under the berths and for admitting warmed air from heat ducts into the car.

Any car can be heated readily, if it is not ventilated. This is economy at the expense of health, since it only requires a very small amount of steam to heat a car, if the air is shut up and not allowed to get out. Moisture in the air is a very essential element in good ventilation, since even pure air is very objectionable when thoroughly dried out. This moisture is usually furnished in good proportions with the outside air admitted to a car by

an indirect heating and ventilating system; but it quickly disappears when the air is retained in a heated car for any length of time. It is easy and cheap to heat confined air, but it becomes a more expensive and a more difficult problem to heat the large quantity of air that must flow through a closed car to furnish good ventilation; or, in other words, to heat the continuous current of fresh air that must be driven through the car and wasted at the ventilators at the rate of 1,000 cubic feet per person per hour. This is health economy at the expense of money, and the price paid may be taken as the extra coal and steam consumption necessary to properly heat this continuous volume of air that passes into the car and out through the ventilators. The volume of air is large and necessarily moves rapidly. This requires a large heating surface and a proper splitting up of the currents as they pass over the steam pipes. No amount of heating surface or steam pressure will be sufficient to heat the car, if the air currents short-circuit around the steam pipes into the car and are not divided and retained long enough in contact with them to absorb the heat. Ventilation would be furnished in any event, but the car would be cold with a high steam pressure in the heating pipes. It is on this account that the mechanical construction of an indirect heating and ventilating system, including the size and arrangement of all the parts, is of much greater importance than is usually supposed. The system may be a success or an utter failure, depending entirely upon the arrangement and the size of the various parts. Thus the necessity will be seen for determining separately, by careful and extended experiments, the details of the heating and ventilating system for each type of car.

The committee recommends that the piping, ducts and openings of an indirect heating system be proportioned and arranged in constructing new equipment so as to furnish sufficient warmed air for the required ventilation of the car; and that, in cases where a satisfactory temperature cannot thus be maintained in severe weather, auxiliary radiators of sufficient size be located inside of the car near the door, or at some other convenient point.

SUMMARY OF RECOMMENDATIONS.

A.—An indirect heating and ventilating system should be used in all new equipment, the air being introduced preferably at the floor and exhausted near the roof.

B.—Ample openings for fresh air should be provided under the lower berths of sleeping cars.

C.—A slight excess pressure or balance of pressure should be maintained inside of a car when the windows and doors are closed, in order to exclude incoming draughts at the windows and crevices. This can only be accomplished by driving the air into the car a little faster than it is drawn out, and means that the movement of the air must be made to pass through the car, largely by driving it in, rather than by drawing it out by means of strong exhaust ventilators.

D.—An ideal system would be one in which the pressures were balanced and the amount of air passed through the car was entirely independent of the speed of the train. From this it follows that the most efficient exhausting device is not necessarily the desirable one to use if its size must be so reduced to prevent overpowering the inlet when running at speed, that the car is almost bottle-tight when at rest. In other words, an exhauster which will act efficiently as a chimney as well as an exhauster, is to be preferred to an exhauster alone, however efficient the latter may be.

E.—Exhaust ventilators, designed for the purpose of completely controlling the movement of air in a car, should be used only for existing Pullman equipment, until it is possible to change this equipment to embrace the advantages of the indirect system of heating and ventilating. The best results from a ventilator with a strong exhaust is obtained in the sleeping car at night, at which time, on account of the enclosed berths, it may be found necessary to resort to the strong exhaust method in order to make an indirect heating and ventilating arrangement sufficiently effective.

F.—Sleeping cars in such service as requires the cars to stand at terminals during a considerable portion of the night, should be specially fitted with an auxiliary forced-draught ventilating system, in addition to the regular ventilating system of the car.

G.—Air should be admitted to and exhausted from a car without its being perceptible to the passengers, and it should not pass through the car in decided draughts when the car is closed. The entering currents, therefore, should be admitted so as not to come in direct contact with the passengers.

H.—A minimum of 1,000 cubic feet of fresh air per hour per passenger should be furnished for good ventilation.

I.—Ventilating tests should be accompanied by a test for carbonic acid of air taken from different heights and from different parts of the car.

J.—The thing most desired in the heating and the ventilating of a car, as well as in the keeping of the seats and general interior clean and comfortable, is to shorten the season during which there is a tendency to open the car windows. This season should have a tendency to be shortened as the conditions of heating and ventilation are improved. The later in the spring that there is a desire on the part of the general traveling public to throw open the windows, and the earlier in the fall that there is a tendency to close them, the more comfortable is the closed car, and therefore, the better the conditions of ventilation and cleanliness. This shortening of the open car season, then, may be taken as an indication of development and progress.

Subjects.

Committee—W. E. Symons, chairman; Wm. Forsyth, H. LaRue.

The committee on subjects for the year 1908-1909, after making thorough and in some cases repeated inquiries from individual members and railway clubs for suggestions indicating subjects for committee reports, has met with the usual results in that very few replies were received. Among these, however, is one which seemed to be of more than usual importance, and we quote the substance thereof as an introduction to this report. This communication is from a prominent railway officer.

"In looking over the subjects assigned to committees by the Association, it seems to me that the matters of greatest interest are very well covered by the standing committees, and the subjects assigned to the special committees are entirely too important to endeavor to settle them definitely between conventions. It has been my feeling that for some time too much work has been undertaken by the Association to be disposed of in a convention lasting but three days, and that either the number of subjects should be decreased or the time of the convention increased. There has not been, in my opinion, a sufficient amount of discussion on the floor of the convention of some of the reports."

The committee not only concurs in the suggestions and criticisms embodied in the above quotation, but would strongly urge that the Association give serious thought, not only to the number of subjects, but the time allotted for their consideration, and acting on these suggestions in the preparation of our report we offer only three subjects for consideration in 1909, in connection with those which are left over from the 1908 convention:

First.—Standard structural shapes for steel freight and passenger cars.

Second.—Standard tests and specifications for car bolsters and definite location of side bearings. The side bearing location to have special reference to the top member or section of truck bolster.

Third.—To recommend as a standard a universal interchangeable steam hose coupler. This committee to specify contour, or outlines, more completely than the present recommended practice, so that these couplers shall be really interchangeable.

Brake Shoe Tests.

Committee—W. F. M. Goss, chairman; George W. West, B. D. Lockwood.

Frictional Qualities of Shoes Submitted.—The committee reported that during the past year five shoes have been submitted by railway companies. Four were sent by Mr. J. F. Walsh, representing the Chesapeake & Ohio Railway Company, and one was sent by Mr. William Garstang, representing the Cleveland, Cincinnati, Chicago & St. Louis Railway Company. These shoes were tested for frictional qualities under the specifications of the Association. The C. & O. shoes were tested upon a cast-iron wheel only, while the C., C., C. & St. L. shoe was tested both upon a cast-iron and a steel-tired wheel. Three of the five shoes tested upon a cast-iron wheel more than met all the requirements of the Association's specifications; two failed to do so. The one shoe tested upon a steel-tired wheel proved satisfactory so far as the mean coefficient of friction is concerned, but developed an abnormally high rise in the coefficient of friction at the end of the stop.

Wearing Qualities of Shoes Submitted.—The four shoes submitted by Mr. Walsh were subjected to a wearing test under a program similar to that employed by the committee in its preliminary investigations which were reported last year. In reporting these results, the committee drew attention to the fact that, as yet, there is no specification governing tests of wearing qualities. The significance of the data must be judged in the light of the other tests made during the year as given below.

THE RESEARCHES OF THE YEAR.

A Review of the Work of Past Years.—It will be remembered that the Association has definite specifications covering the frictional qualities of brake shoes, and that the work of the committee, during recent years, has been confined to testing shoes under these specifications. The effect of this work has been to stimulate interest in the brake-shoe problem, and to make of record information concerning the action of shoes on both cast-iron and steel wheels. The fact that most shoes recently tested have met the requirements of the Association's specifications, may be accepted as evidence that its work has been effective in improving the friction of shoes sold to railway companies. Two years ago attention was called to the need of information con-

cerning the wearing qualities of brake shoes, and under authorization from the executive committee, initial steps were taken to establish tests which would serve as a measure of wear. The report of last year (see AMERICAN ENGINEER, July, 1907, p. 282) was devoted almost exclusively to a discussion of methods and to the presentation of results obtained from fifteen different shoes when exposed to wear under a definite program. The results, which were obtained by exposing the shoe to wear under a single set of conditions only, showed great variation in the wearing qualities of the several shoes tested. The purpose of the committee during the present year has been to throw light upon this question. To this end arrangements were entered into with the authorities of Purdue University to extend the work along the lines of last year's investigations. Out of the fifteen shoes dealt with in last year's report, there were nine presenting sufficient material to serve under the program of the present year. These shoes are described and illustrated in the report of last year.

The Schedule of Tests.—Each of the nine shoes has been tested both upon a cast-iron wheel and upon a steel-tired wheel; first, when applied under a lighter pressure than that employed last year, and second, when applied under a heavier pressure than that employed last year. Also since the tests last year were upon cast-iron wheels only, the program of that year has been repeated upon the steel-tired wheel. In the actual working out of the program, each shoe was tested under a normal pressure of 1,080 pounds and 4,152 pounds on a cast iron wheel and under pressures of 1,080, 2,808, and 4,152 pounds on a steel-tired wheel. The cycle, as controlled by Gear B, was used for the tests under pressures of 1,080 and 2,808 pounds, and that, as controlled by Gear A, was used for the heaviest pressure, 4,152 pounds, this change being necessary to give the shoe sufficient time to cool between applications. When the cycle is controlled by Gear A,

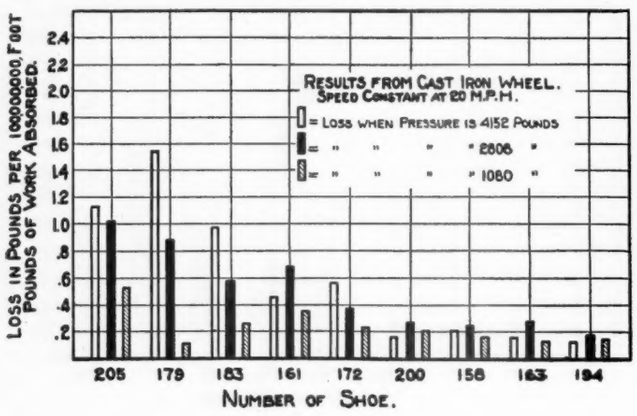


FIG. 1.

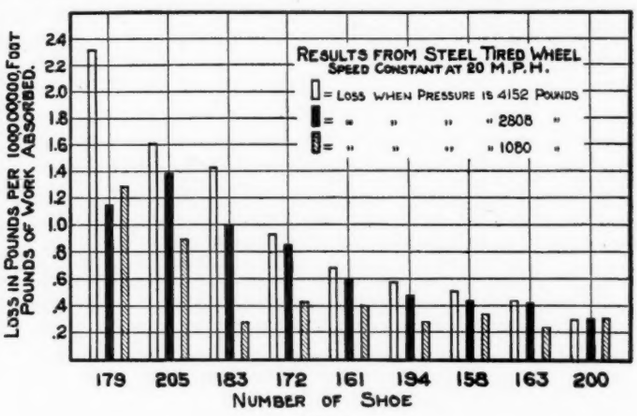


FIG. 2.

the shoe is in contact with the wheel during 150 revolutions, and is out of contact during the succeeding 1,450 revolutions, the shoe being applied once during each 1,600 revolutions of the wheel. When the cycle is controlled by Gear B, the shoe is in contact with the wheel during 190 revolutions, and is out of contact during the succeeding 610 revolutions, the shoe being applied once for each 800 revolutions of the wheel. The speed in all cases was equivalent to twenty miles an hour. A summary of results is presented graphically by Figs. 1 and 2.

Conclusions Concerning Wearing Qualities may be drawn from results presented as follows:

(a) The shoes tested present great variation in the wearing qualities, the ratio between the poorest and the best shoe being as great as 1 to 4.

(b) The relative resistance to wear exhibited by different shoes is somewhat affected by the severity of the application. Of a series of shoes, the one which suffers least from wear at light pressures may not be the one which suffers least under a heavy pressure. Variations of this sort are, however, of small value, and if standards of performance are not too minutely defined, they may be neglected.

(c) Within limits employed by the committee, whatever may be the pressure, the results clearly distinguish between the slow wearing and the rapid wearing shoe.

(d) All shoes tested wear more rapidly on a steel-tired wheel than on a cast-iron wheel. In general terms it may be said that for the absorption of a given amount of work, the wear upon steel-tired wheels is twice as rapid as upon cast-iron wheels.

(e) The results attest the value of the insert shoe. The work of this year was chiefly confined to shoes of this type because the solid shoes had been worn out by the tests to which the series had previously been subjected. (For facts concerning solid shoes, see report of 1907.)

(f) It is noteworthy that the four shoes showing least wear, 158, 163, 194 and 200, on both steel and cast-iron wheels, are all insert shoes, and that all practically meet the Association's specifications as to frictional qualities. (For statement of frictional qualities, see report of 1906, AMERICAN ENGINEER, August, 1906, p. 315.)

Concerning Limits of Allowable Rate of Wear in Brake Shoes.—It is not the purpose of the committee to attempt at this time to frame a specification governing the wearing qualities of brake shoes, though the data presented seems to supply a satisfactory basis for such a procedure. We suggest, however, as a matter for further deliberation, the following qualifications:

(a) The tests designed to determine the wearing qualities of brake shoes be run under a constant brake shoe pressure of 2,808 pounds.

(b) That the cycle of operation be 1,600 revolutions, 150 revolutions being with the shoe in contact with the wheel, and 1,450 being with the shoe in release.

(c) That the peripheral speed of the test wheel be twenty miles an hour.

(d) That under the conditions stated, a shoe should develop for each pound of metal worn away, 350,000,000 foot-pounds of work in contact with a cast-iron wheel, and 200,000,000 foot-pounds of work in contact with a steel-tired wheel.

A specification framed along these lines would pass four out of the nine shoes tested for service on both cast-iron and steel-tired wheels.

Future Work.—The committee believes that the work of the present year leaves two questions open which should be settled beyond doubt before a specification governing wearing qualities should be adopted. These are: (1) A confirmation of the general conclusions based upon the work of the present year; and (2) investigations which will disclose the effect of different brake shoes upon the wheel. With reference to the confirmation of the results of the present year, it would seem wise that not less than fifteen newly selected representative shoes be tested, the program of operation being identical with that employed this year. The results of such tests added to those now available would give a volume of data sufficient to permit limits to be set defining performance, which would be safe and reasonable. The importance of determining the effect of the shoe upon the wheel becomes apparent when the possibility of a shoe showing a high resistance to wear, which may, in fact, be protected at the expense of wear upon the wheels is considered. In discussing this matter last year, the committee expressed its regret "that no measure has yet been made which will disclose the wear of the wheel under the influence of the shoe." To secure such a measure, it will be necessary to have a balance of sufficient capacity to weigh the wheel and of such delicacy as to indicate differences of weight as small as 1-500 part of a pound. No such balance is now available at the laboratory.

Cast Iron Wheels.

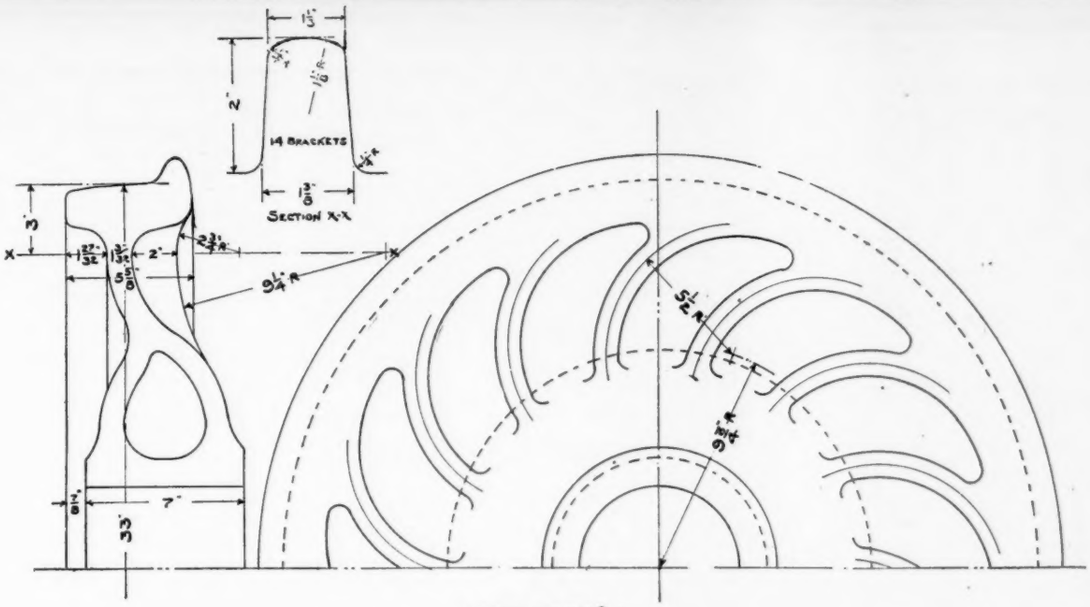
Committee—Wm. Garstang, chairman; A. S. Vogt, H. J. Small, W. E. Fowler, R. L. Ettenger, R. F. McKenna.

The standing committee on cast iron wheels reports the following outline of work accomplished since the 1907 convention:

The recommendations of the committee, in its report for 1907, having been submitted to letter ballot and accepted as an entirety by the Association by affirmative vote on each and all of the recommendations, has limited the committee in its work during the past year to suggested additions, alterations and revisions pertaining to the subject, as follows:

WHEEL DEFECT AND WORN COUPLER LIMIT GAUGE.

Now appearing on M. C. B. Sheet 12, and showing three slots for gauging worn wheel flanges, has been recommended for revision as shown on WC-1908-3 with two slots for gauging worn flanges, for the following reasons: The worn coupler and wheel defect gauge, as presented to the Association in 1907, in which 1-inch, 1 1-16-inch and 1⅛-inch slots for gauging worn flanges was shown, has, on account of the ⅜-inch radius used, been criticised for the reason that the fillets at the throat of

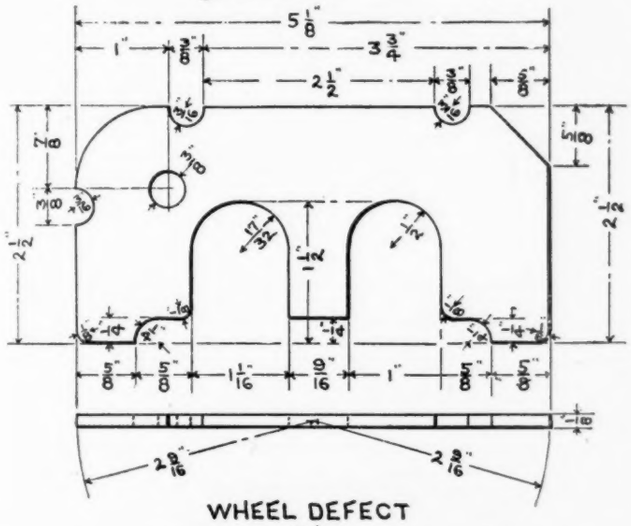


SHEET WC-1908-5.

worn wheels on which this gauge would be used, differ from the radius on the gauge, thereby preventing the latter from properly seating in the throat and resting on the tread, which results in the gauge not being applied perpendicularly and renders the uniform condemning of wheels an impossibility, notwithstanding that the ⅜-inch radius recommended by the committee is very much closer to the actual fillet in the throat of worn wheels than the radius used on the M. C. B. gauge, which was standard prior to the committee's report.

This gauge has been further recommended for revision in the elimination of the 1⅛-inch wide slot for condemning wheels under 100,000 pounds capacity cars.

The committee, in investigaitng both points above referred to, are unanimously of the opinion that both are well taken and



WHEEL DEFECT
AND
WORN COUPLER LIMIT GAUGE.

they hereby present Sheet WC-1908-3 and WC-1908-4 (not reproduced), showing a proposed new gauge and method of using it to cover the above points, and which it is possible to use in condemning worn M. C. B. standard wheels alike, notwithstanding whether they have the standard flanges in vogue up to 1906 or the strengthened flange of wheels cast under the standard of 1907.

SHAPE OF BRACKETS OR RIBS.

The present "M. C. B. Recommended Practice" for cast-iron wheels as shown by Sheet "J," which requires fourteen brackets supporting the tread and flange at the back face of the wheel adjacent to the single-plate portion, has been criticised for the position of the brackets, which it is claimed does not follow good foundry practice, and also for their shape, which it is stated, permits unequal strains to be set up in the wheel when cooling. Attention having been invited to these details by Mr. Muhlfeld, the committee, after investigation, is unanimous in its opinion that both are well taken, and hereby presents Sheet WC-1908-5 as covering the desired changes.

The attention of the committee has been directed to the fact that none of the cuts published in the proceedings show in detail with necessary dimensions the contour of the tread and flange for steel tires. The suggestion has been made that M. C. B. Sheet A of recommended practice be revised to show in detail with all necessary dimensions the contour of the tread and flange for steel tires, and the title of the sheet altered to include "Tread and Flange for Steel-tired Wheels." The committee is of the opinion that this should be done, making the same correspond to the contour of the wheel tread and flange (from the outside of the tread to the point of the flange only) shown on M. C. B. Sheet A of recommended practice and now used for cast iron wheels. Action on this point should be taken by the Association, as it is beyond the province of this committee to include it in its recommendations.

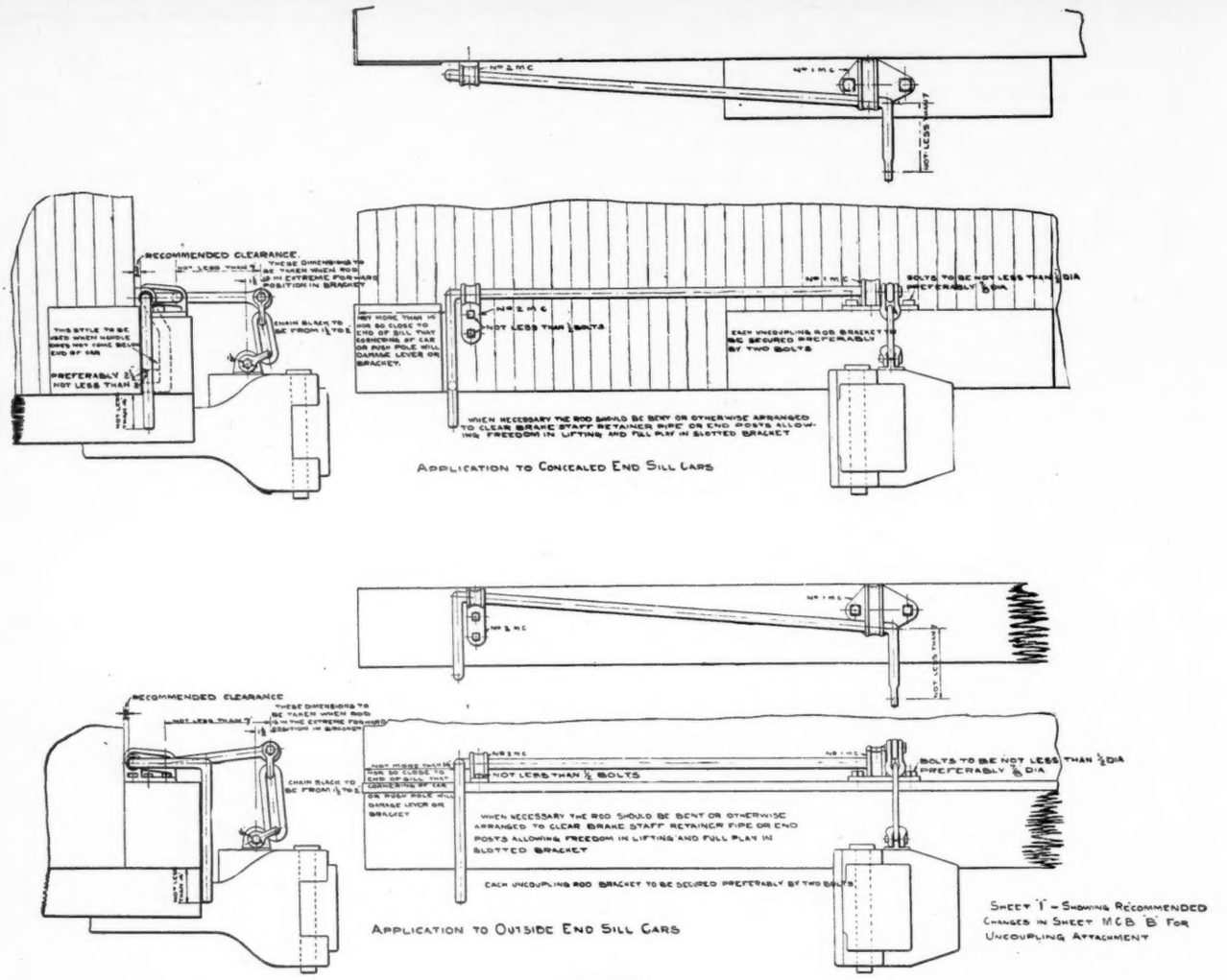
In concluding its report to the Association in 1907, the committee recommended that a service record of the performance of the new wheels be maintained by the members of this Association, for a sufficint period of time to determine what the wheels would do under the increased wheel loads and mileage, so that, if it was desired by the Association to adopt a guarantee, that the actual performance of the wheels could be used in determining what the guarantee should be. After one year's experience with the new wheels, the committee is of the opinion that at least the leading railroads of this country have complied with this request and that there is now sufficient data in the hands of the individual members that can be used by the committee in framing a proposed guarantee, provided the Association votes that one be framed.

Tests of M. C. B. Couplers.

Committee—R. N. Durborow, chairman; G. W. Wildin, F. W. Brazier, T. H. Curtis, F. H. Stark.

The executive committee referred the following subject to the standing committee on tests of M. C. B. couplers: "The investigation of the cause of broken links and clevises, bent uncoupling rods, and to submit a design of uncoupling rod to obviate these troubles."

An examination was made of several thousand uncoupling attachments and a careful and detailed investigation of 1,764 of this number as regards design, application, condition, maintenance, repairs and operation. This was conducted on five railroad systems, and as both foreign and home cars were inspected it covers practically all classes of cars offered in interchange, as well as all kinds of attachments. The results are tabulated on Sheet 3, patented devices not being included in these statements. Four main styles of uncoupling attachments for M. C. B. couplers are found, namely, single-end rods on concealed end sill cars, single-end rods fastened to front of end sill on projecting end sill cars, single-end rods fastened on top of end sill close to body on projecting end sill cars and double-ended rods. Attention is directed to certain particulars brought out in the investigation shown on Sheet 3. The general design, application and maintenance of some uncoupling attachments is not altogether satisfactory, for example, 22 per cent. of the rods will not operate the coupler knuckle throw, and 11 per cent. will not raise the lock to the lock-set position, 18 per cent. have un-


RECOMMENDED CLEARANCE
NOT LESS THAN 7
THESE DIMENSIONS TO BE TAKEN WHEN ROD IS IN EXTREME FORWARD POSITION IN BRACKET
CHAIN SLACK TO BE FROM 1½ TO 2
THIS STYLE TO BE USED WHEN HANDLE DOES NOT COME BELOW END OF SILL
PREFERABLY 2½ NOT LESS THAN 2
NOT LESS THAN 5
NO MORE THAN 10 NOR SO CLOSE TO END OF SILL THAT CONNECTING OF CAR OR PUSH POLE WILL DAMAGE LEVER OR BRACKET
No 2 M C
NOT LESS THAN ½ BOLTS
No 1 M C
BOLTS TO BE NOT LESS THAN ½ DIA PREFERABLY ⅝ DIA
EACH UNCOUPLING ROD BRACKET TO BE SECURED PREFERABLY BY TWO BOLTS
WHEN NECESSARY THE ROD SHOULD BE BENT OR OTHERWISE ARRANGED TO CLEAR BRAKE STAFF RETAINER PIPE OR END POSTS ALLOWING FREEDOM IN LIFTING AND FULL PLAY IN SLOTTED BRACKET
APPLICATION TO CONCEALED END SILL CARS
APPLICATION TO OUTSIDE END SILL CARS
SHEET 'I' - SHOWING RECOMMENDED CHANGES IN SHEET M.C.B. 'B' FOR UNCOUPLING ATTACHMENT

SHEET I.

coupling rods with center arm only three to six inches long, and 17 per cent. have a chain slack as much as from three to seven inches; split links and "S" hooks combined average 12 per cent.; more than one-half of the brackets are applied with lag screws instead of bolts and 71 per cent. of the links and 74 per cent. of the clevises are of smaller size than the recommended practice, which calls for 5/8-inch links and clevises. The style of rod fastened to front of end sill is the least efficient, while, in general, the single-end rod on concealed end sill cars and the single-end rod on back of end sills give better service. Besides the data contained on attached sheets, a large number of uncoupling attachments were found having loose lag screws, rods binding on brake staffs, retainer pipes, ends of car, etc., and with the handle improperly located.

Answers to a circular letter sent out showed that excessive slack in draft rigging is largely responsible for broken links and clevises and for bent rods, but this condition is seldom found on steel and steel underframe cars equipped with high capacity spring or friction draft gears. It is found largely in the older and lighter equipment having wooden draft arms with single springs and three-bolt draft stops bolted to side of draft timbers and not gained into them, which are not maintained in proper repairs for service under varying conditions.

In this connection it should be noted that the release rigging on these older cars are designed for use with the couplers without lock-set in the coupler head, but lock-setting was accomplished by supporting the release rod on a shelf provided on the end bracket, which required a neat adjustment of chain. This design worked out very well for the couplers in use during that period when chains had sufficient slack, as the draft arrangements were adequate for the weight of trains handled. Now, however, these same cars are having the modern lock-setting and knuckle-throwing types of couplers applied, requiring as much as six inches lift, using the same length arm on rod and same chain connection which was used when springs were subjected to 25,000 pounds pull. Whereas, now, two engines are frequently used exerting a tractive force of from 70,000 to 80,000 pounds, while the stresses in trains due to rough handling have been accurately measured and found sometimes to exceed 600,000 pounds. This condition is bad enough in the type of draft rigging noted above, but the worst conditions are present on cars equipped with the American continuous draft gear. There are now, however, relatively few of the latter in service, and these are being replaced with improved types of draft gears.

Rods.—On some of the older types of couplers the lock does not operate in a central vertical plane and the rod should be changed when an M. C. B. standard coupler is applied, but this is not often done and the old rod causes certain difficulties in the operation of the coupler. On box cars with concealed end sills, uncoupling rod is liable to be made inoperative when end of car is forced outward; on all forms of uncoupling rods and particularly double-ended rods requiring more than two bearings this trouble is rather pronounced and is aggravated by often using such brackets that place the rod close to the siding so that slight bulging of the end interferes with operation of rod. Proper care is not taken to offset or locate rods a sufficient distance from brake staff, retainer pipe, end posts, etc., to provide the necessary clearance for operation. Occasionally bends made to clear these obstructions allow insufficient movement of rod to properly throw the knuckle. Double-ended release is preferred by some; however, it is a fact that these double rods are frequently bent and are liable to become totally inoperative. Bent rods attributed to shifting loads are frequently damaged by coming in contact with rods on coupled cars when the slack in the train is bunched. Rods with long center arms located on face of end sill, with draft gear in release position, on which the eye of rod is more than two inches ahead of eye of coupler lock are liable to interfere when coupler horn is against striking plate, especially when draft attachments and end sills are in a worn condition. A rod with the handle on the side of car is undesirable on account of interference with the use of the sill step and its liability to become bent or broken in such an exposed position.

Brackets.—The design and attachment of brackets have an important influence on the operation of the uncoupling attachment. The usual brackets allowing but little play to the rod are a source of inoperative uncoupling attachments. The committee believes that the best form of center bracket is one having a slot which gives the rod about 3½ inches longitudinal

INVESTIGATION OF UNCOUPLING ATTACHMENTS

SHOWN IN PERCENTAGES

KIND OF ROD	DRAFT GEAR	NUMBER EXAMINED	BRACKETS SECURED BY: CENTER BOLTS	CENTER LAGS	OUTSIDE BOLTS	OUTSIDE LAGS	SIZE OF LINKS: 7/8"	3/4"	5/8"	9/16"	1/2"	SPLIT LINKS	'S' HOOKS	SIZE OF CLEVISES: 3/4"	5/8"	9/16"	1/2"	NO CLEVIS	WILL NOT OPERATE: LOCK SET	KNUCKLE THROW	LENGTH OF CENTER ARM: 1" TO 3"	3" TO 6"	6" TO 9"	9" TO 12"	12" TO 15"	AMOUNT OF CHAIN SLACK: 0 TO 1"	1" TO 3"	3" TO 7"	RELATIVE POSITION A LIFT PIN EYE & LOCK PIN EYE: A MORE THAN 5" BEHIND	A 1" TO 5" BEHIND	A 1" AHEAD TO 1" BEHIND	A MORE THAN 1" AHEAD	BENT ROD
SINGLE END ROD ON CONCEALED END SILL CARS	SINGLE SPRING	319	20	80	1	99	3	22	41	9	4	15	6	17	66	16	4	3	11	17	1	15	78	6	1	44	43	13	2	27	46	23	20
	TANDEM SPRING	295	49	51	19	81	1	15	54	26	3	5	2	11	62	22	4	1	11	19	0	10	79	11	0	40	42	18	2	13	64	21	12
	TWIN SPRING	167	37	63	15	85	1	18	58	11	3	8	1	8	75	13	2	2	8	19	0	9	72	18	1	42	42	16	1	13	68	18	10
	FRICTION	33	61	39	49	51	0	30	61	3	0	10	0	12	73	0	3	10	6	10	0	0	76	21	3	61	21	18	0	12	67	21	24
	TOTAL	814	36	64	12	88	2	19	50	13	3	10	3	13	65	16	4	2	10	18	1	10	76	12	1	45	41	14	2	18	59	21	13
SINGLE END ROD FASTENED TO FRONT OF END SILL	SINGLE SPRING	210	27	73	5	95	3	16	48	11	10	9	3	13	59	15	10	3	16	24	3	10	80	5	0	43	42	15	3	12	45	38	13
	TANDEM SPRING	128	55	45	31	69	1	12	62	17	2	4	2	9	66	19	2	4	15	38	1	29	60	10	0	48	43	9	0	10	68	22	12
	TWIN SPRING	125	36	64	27	73	0	8	73	4	2	11	2	4	80	10	2	4	12	18	1	12	80	7	0	36	51	14	2	8	71	19	6
	FRICTION	25	76	24	76	24	0	0	48	40	0	12	0	0	68	24	4	4	8	12	0	60	40	0	0	36	40	24	4	4	60	32	4
	TOTAL	488	39	61	21	79	2	12	58	12	5	8	3	9	67	16	6	2	14	25	2	44	47	7	0	42	44	14	3	10	59	28	11
SINGLE END ROD FASTENED TO BACK OF END SILL	SINGLE SPRING	15	80	20	20	80	0	40	53	7	0	0	0	13	80	1	0	0	13	20	0	0	87	13	0	40	60	0	13	13	54	20	27
	TANDEM SPRING	52	60	40	46	54	0	15	63	14	0	4	4	4	67	23	4	2	6	17	0	4	52	19	25	29	50	25	4	18	67	11	11
	TWIN SPRING	90	93	7	92	8	0	8	87	3	1	1	0	0	78	22	0	0	13	34	0	0	7	26	67	16	52	32	0	11	70	19	12
	FRICTION	148	97	3	99	1	1	4	62	15	12	4	2	0	62	22	13	3	8	30	0	1	6	43	50	43	38	19	1	10	68	21	23
	TOTAL	305	88	12	84	16	1	9	69	10	6	3	2	13	68	22	7	2	10	25	0	1	19	32	48	31	44	25	2	11	68	19	17
DOUBLE END ROD	SINGLE SPRING	47	15	85	2	98	2	32	34	17	9	6	0	13	51	26	10	0	4	15	0	6	81	13	0	51	29	20	0	36	49	15	23
	TANDEM SPRING	80	50	50	38	62	0	10	54	32	0	4	0	0	61	38	1	0	4	32	0	6	75	13	6	41	43	10	2	10	68	20	25
	TWIN SPRING	55	42	58	18	82	0	30	55	6	0	6	3	27	58	15	0	0	12	18	0	6	68	20	6	40	40	20	0	6	70	24	12
	TOTAL	140	38	62	25	77	1	20	48	22	2	5	1	9	57	29	5	0	6	20	0	16	73	16	5	41	38	15	1	17	65	19	33
GRAND TOTAL		1764	46	54	28	72	1	15	55	13	4	9	3	9	65	18	5	3	11	22	1	18	58	14	9	40	43	17	2	15	61	22	14

SHEET 3.

travel and is attached to the car by bolts. The outside bracket on wooden cars is generally attached by lag screws and, as it is usually necessary to remove these lags to straighten bent rods, it is felt that bolts are preferable. There are two or three brackets on the market allowing the rod to be removed without removing the bracket itself, which is a good feature, especially for yard repairs. On steel equipment the brackets are usually attached by bolts and no trouble is experienced. Occasionally they are attached by rivets, which is undesirable, because it is either necessary to straighten the rod on the car or to cut off the rivets, unless the brackets are of that type mentioned above.

CHAINS.—Short chains is a condition not confined to the old wooden cars, but is frequently seen on steel and steel underframe cars of modern construction. One reason for this is that the coupler manufacturers usually provide a chain of fixed length which is being used for all designs of rods and car end constructions, instead of arranging the length of chain with reference to the end construction, type of rod used, travel of gear, etc. This defect is noted more frequently on cars equipped with couplers having the floating type of lock, which are generally provided with a chain so that a clevis only is necessary to connect lock to rod. This difficulty has been avoided in some instances by using an extra clevis or a clevis provided with two holes. It is recommended that these chains must have an eyelet above locking-pin hole so that the recommended links and clevises can be used. This should avoid the use of split links and "S" hooks.

"Kinked chain" is a defect usually found on the floating lock type of couplers, the links wedging in coupler head so that repeated jerking on the rod fails to dislodge them, making adjustment necessary. Insufficient attention is given to this matter, and it is felt that, were the links for this purpose secured and well-fitted to locks, less trouble would be experienced. Couplers having a long single-piece lock require close adjustment of uncoupling attachment to prevent binding and consequent heavy duty on the release rod and chain. The use of a large number of links of small chain should be discouraged, as they break easily, and when one link breaks it is usually replaced by an "S" hook or split link. It follows that the best practice is the use of two heavy malleable iron clevises cored for ¾-inch pins connected by a single heavy wrought iron or malleable link.

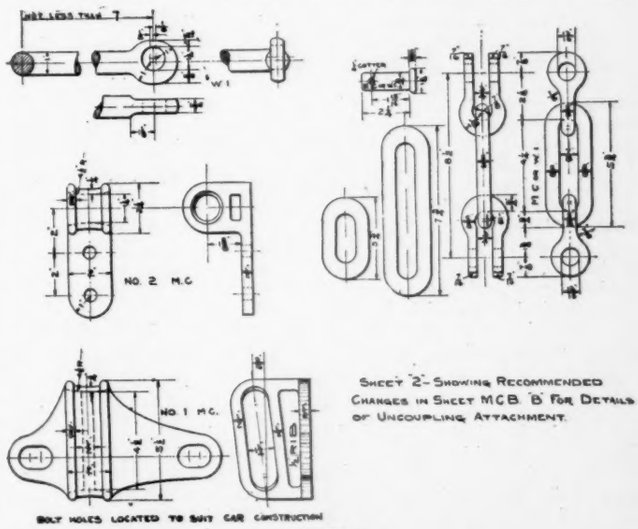
Improper or light material both in original construction and in repairs is a large factor in the increased number of bent uncoupling rods and of broken links and clevises; the use of split links and "S" hooks instead of clevises and bolts instead of pins, contributes to a large number of failures. There is little excuse for these practices on the shop tracks and in the yards; such points should be provided with a supply of standard links, clevises and pins to insure cars being repaired with standard material. Attention is directed to the fact that certain coupler companies are furnishing clevises which use the ½-inch instead of the recommended ¾-inch pin. The use of bolts should be discouraged, as the nut works off, making uncoupling attachment inoperative. Large cotter pins are also used instead of the recommended ¾-inch pins.

There are other causes for bent rods and broken links and clevises, many of which are not chargeable to design or maintenance of uncoupling attachment, but solely due to carelessness of those handling cars. Cars cornering in yards is the cause for a great many bent rods, as is also the careless use of push poles.

INTERFERENCE WITH PASSENGER CAR BUFFERS.—From the answers received there is apparently little trouble from the buffers of passenger equipment making uncoupling attachment of freight equipment inoperative when these two classes of cars are coupled together. It is not the practice on many roads to run freight equipment cars in main line passenger service, but where this is done, either the buffers are removed, or some special release device is used. The use of the two classes of equipment together is largely confined to branches where the passenger equipment is of the older type, and, having the two circular buffers, little difficulty is found in the way of interference.

PROPOSED UNCOUPLING ATTACHMENT.—It is the belief of the committee, based on the replies to the circular of inquiry and on the investigation made, that considerable trouble from inoperative attachments is due, first, to not taking into consideration, when designing, all the various elements necessary for efficiency in operation and repairs; and second, a lack of proper attention to maintenance after application. It is believed that for all classes of cars and for all couplers which come under the M. C. B. Standards a single ended rod properly designed is the most suitable arrangement not covered by patents that can be used. Acting on this, changes are suggested in M. C. B. Sheet B, which it is thought will overcome the defects in design and reduce to a minimum the troubles incident to improper maintenance; this is shown on Sheets 1 and 2.

The special feature of this uncoupling attachment is the slotted center bracket, which has been in use on a number of roads



SHEET 2—SHOWING RECOMMENDED CHANGES IN SHEET M.C.B. 'B' FOR DETAILS OF UNCOUPLING ATTACHMENT.

SHEET 2.

for some time, and very few cases of bent rods, etc., are found on cars so equipped. By placing the rod back on top of end sill or head block a longer arm is obtained, which gives sufficient lift with ample slack in the chain, and by using a sloping slotted bracket the rod projects 1½ inches in front of coupler lock, which is about the best position for an efficient lift. The slotted bracket allows the rod to slide back 3½ inches and avoids interference when slack of train is bunched.

The handle shown should preferably project below end of car or be bent as shown by dotted lines on Sheet 1, in order to protect the operator's hand.

The present Recommended Practice Sheet B, shows a chain 8½ inches long with one 5¾-inch link; the proposed recommended practice shows two additional links 3¾ inches and 7¾ inches long, respectively. By using one of these three links, therefore, a chain 6½, 8½ or 10½ inches long is obtained, which should fit all cars and M. C. B. couplers. These links should avoid the use of split links, "S" hooks and other temporary repair devices now very common. The arrangement as a whole is applicable to all types of cars, and if properly applied will largely obviate present troubles. Only a few limiting dimensions are shown on the drawing, as the others must be adapted to each particular class of car; but the dimensions for center arm, chain slack and position of lift pin eye should be carefully adhered to.

SIDE AND BOTTOM OPERATING COUPLERS.—There are a number of types of side and bottom operating couplers in service to a limited extent on several roads, some of which present good features. The committee has also examined some types of these couplers in process of development at the works of the manufacturers, and the best that can be said is that they are still in an experimental stage. The main objection that can be seen at the present time is that each coupler requires a special form of uncoupling attachment. On the side operating couplers the rods, bell cranks and pivot points, provided on the coupler head, are liable to be damaged by couplers passing on curves of short radius. On the bottom operated couplers similar conditions prevail with the addition that, in some forms, the uncoupling attachment is secured by drop hangers, which are likely to become damaged by coming in contact with certain designs of bumping posts. Furthermore, a great number of parts are usually required for these uncoupling attachments.

It has been suggested that the specifications should be modified to permit the use of the side and bottom operated couplers. Not long since there was a decided sentiment in favor of adopting one standard coupler, which was found impracticable at that time, and the committee was instructed to continue making the specifications more rigid, with the object of ultimately reducing the number of types of couplers to a minimum, and therefore retaining only those embodying designs which will give both maximum strength and the best operating properties. As a result of this the M. C. B. coupler has been developed to that point where a common standard uncoupling attachment can be used with all types meeting the specifications, and consequently the number of repair parts for both coupler and uncoupling attachment are relatively small. In addition to this the proposed couplers have only been tested in service to a very limited extent.

In view of the foregoing, it is believed inadvisable to open the specifications to admit the use of side or bottom operated couplers until such time as the merits of either one of these can be recommended in place of the present standard, but in order to ascertain the availability of these proposed devices, the committee would suggest that they be given an extended trial by different railroads on cars of their own equipment, preferably on those not offered in interchange.

In view of past experience the committee believes that changes in the recommended practice and standards of the Association should only be suggested after careful deliberation, especially in cases of experimental arrangements, which should be thoroughly tried out before being included in specifications, so as to avoid too rapid changes, which may result in error, and with this in mind the above view of the question is taken.

OPERATION AND CONDITION OF COUPLERS.

With a view of obtaining definite information relative to the operation and condition of couplers in service, the committee made an investigation of about fifty each of the ten most prominent types, and results are tabulated on Sheet 6. The numbers at the top, representing the names of the couplers, are the same used last year, with three additional types, and are arranged in chronological order with the older couplers on the left. No data was taken in cases where the coupler had been fitted with improper parts, such as wrong knuckle pins, or where the uncoupling attachment did not operate properly.

It has developed that when some of the coupler manufacturers changed the contour lines of the couplers in accordance with the standards of the Association, they neglected to fill in the lines of the knuckle contour sufficiently to coincide with the new lines resulting from the addition of metal across the knuckle lugs of the bar, leaving an opening between the knuckle contour lines and the lines of the bar when knuckle is closed. This prevents the point of the mating knuckle engaging the knuckle tail continuously until the lock drops. Another item entering into the mating of couplers is the failure of some coupler knuckles giving a full opening. The point of knuckle should be in a line with the inside of the lugs on bar, which line should be parallel with the longitudinal center line of coupler.

COUPLER SPECIFICATIONS.

A summary of the recommendations which the committee offers to be submitted to letter ballot, to be adopted either as standard or recommended practice, is as follows:

STANDARDS.

1. That 1¼-inch rivets be used for attaching yokes to coupler butts, and that Sheet M. C. B. 11 be changed to conform to this recommendation, showing 1 5-16-inch rivet holes in coupler butts.

2. That the following be added to third sentence of paragraph 5 of specifications for automatic couplers, "and the rivet holes in the butts must be drilled, or if cored, must be broached out."

3. That all new types of couplers put on the market after January 1, 1909, have a dimension of 9¼ inches from back of coupler horn to inside face of knuckle, and that the face or front wall of coupler have a minimum thickness of 1¼ inches, and that a note to this effect be added to coupler drawings on Sheet M. C. B. 11.

4. That the total lift of the locking pin be not more than 6 inches, and that a note to this effect be added to coupler drawing on Sheet M. C. B. 11.

5. That all couplers must have an eyelet for locking device located immediately above locking-pin hole, so that the recommended links and clevises can be applied, and that a note to this effect be added to coupler drawings on Sheet M. C. B. 11.

6. That the pulling test under specifications for automatic couplers be changed to read as follows: "The couplers must stand a steady pull of 150,000 pounds." "A coupler shall be considered as having failed to stand this test . . . if the knuckle has opened more than ⅝ inch. . . ." "Should either or both couplers fail to stand the prescribed test, but both stand 100,000 pounds, another complete coupler or pair of couplers shall be provided. . . ."

OPERATION AND CONDITION OF COUPLERS

	KIND OF COUPLER										AVERAGE
	1	2	6	4	9	8	25	5	23	24	
AVERAGE DISTANCE - POINT OF KNUCKLE TO GUARD ARM	4 7/8"	4 13/16"	4 7/8"	4 15/16"	4 7/8"	4 15/16"	4 15/16"	4 3/4"	4 3/4"	4 13/16"	4 7/8"
PER CENT KNUCKLE THROW INOPERATIVE	NOT KNUCKLE THROWING COUPLERS			5	61	35	31	32	11	11	27
PER CENT LOCK SET INOPERATIVE	63	3	2	0	6	6	0	0	0	0	7
PER CENT KNUCKLE TAIL BEARING WORN	4	3	17	36	0	0	5	0	11	0	8
PER CENT LOCK BEARING WORN	0	3	4	16	0	0	0	0	0	0	2
PER CENT PIVOT PIN BENT	4	0	6	3	3	0	0	0	0	37	5
PER CENT PIVOT PIN WORN	2	3	17	7	9	2	0	0	0	20	6
PER CENT PIVOT PIN HOLE WORN	20	12	23	28	9	50	17	4	11	54	23
PER CENT BENT OR BROKEN LOCK	0	0	0	0	6	4	9	4	0	3	3
AVERAGE PER CENT	14	3	10	12	12	11	8	5	4	16	10

SHEET 6.

RECOMMENDED PRACTICE.

1. That drawing on Sheet M. C. B.—B, showing coupler butts, be omitted, as this will be identical with butts shown on Sheet M. C. B. 11.

2. That drawing of uncoupling attachment on Sheet M. C. B.—B be changed to conform to Sheets 1 and 2 attached, and that recommend practice for uncoupling arrangements be also changed so as to conform to this recommendation.

FRICTION DRAFT GEAR.

The executive committee requested the committee on M. C. B. couplers to recommend a standard maximum capacity for friction draft gears, and the most desirable resistance during each ⅛-inch compression, also to report to the value of friction draft gear in reducing damage to cars and their contents. To secure data on the above subject, there was referred to the members a circular of inquiry to which replies from 53 railroads, representing 904,000 cars, were received.

The committee, in sending out this circular of inquiry, realized that the use of friction gear is by no means general, and also that while a number of road tests showing the stresses to which trains are subjected have been made, there is little reliable data which shows the frequency of the high pulling and buffing strains in road service. The whole question is quite complicated, as it should take in the question of the influence of heavy steel equipment with friction gears on the older light capacity wooden equipment with spring gears.

The replies in general seem to be based on the capacity of the gears now on the market, a decided preference being exprssed for a capacity of about 150,000 pounds. At present, the better types of spring gears have a capacity of about 60,000 pounds, and absorb practically no work, the compression being sent back into the train as recoil. The ordinary pulling and buffing forces when train is in motion do not usually exceed 40,000 pounds when train is handled by one engine, but there are shocks due

to engines coupling on trains, yard switching, etc., which are of frequent occurrence and often exceed 100,000 pounds. When there is a lack of attention in gravity yards and brake maintenance and operation is faulty, stresses of 600,000 pounds have been exceeded, and on road brake tests with the maximum poor conditions stresses of 500,000 pounds have been recorded.

In general the car framing, draft gear and attachments should be considered not only for the home road, but also with reference to conditions on roads with which the cars will be interchanged. In case cars are subjected to small stresses, a low-capacity draft gear equal to these stresses is more satisfactory than a high-capacity gear of same travel, as in the latter case there will be more shock transmitted to the car framing, because the small shock is taken up in a short travel in the high-capacity gear. From these considerations 150,000 pounds seems to be a desirable capacity for general service where cars of all types are made up in the same train. Roads handling heavy trains of steel cars loaded with coal, ore, etc., and not interchanging these cars, may find it advantageous to use gears having a capacity of 300,000 pounds or more with the present travel, as experience has shown that on the better class of modern steel cars the attachments are amply strong and the car framing is sufficient in strength to stand severe shocks. It would be inexpedient to make equipment wreck proof, when there is still much to be accomplished in the improvement of braking conditions, such as better maintenance of the brake apparatus and more careful handling by the train crews.

The distribution of work in the friction draft gear is a more important factor than the maximum capacity, for it has been shown by tests that with two gears, one of which has a much higher capacity than the other, the first by reason of its distribution of work transmits more shock to the car framing than does the second, the maximum capacity of the first being 50 per cent. greater than the second. As has been previously stated, the vast majority of the shocks in the train when brake equipment is in good condition and properly handled are not much more than the maximum tractive power of the engine, which on an average is about 40,000 pounds. From this it follows that a friction draft gear should have a capacity of 30,000 to 40,000 pounds in the first 1 to 1½-inch travel, and then the capacity should be increased to a maximum which with present travel it is believed should be from 150,000 to 200,000 pounds. Experience has shown that with much more capacity than the above with the present travel the transition from the preliminary spring action to the frictional operation is not smooth, and transmits severe shocks to the attachments and car framing. Therefore, the results from gears of 300,000 pounds capacity are often less satisfactory than those having 150,000 pounds, assuming the diagrams similar in relation to release.

In this respect, providing there is smooth action in the compression, the friction gear has a unique advantage due to the absence of large recoil, the work being absorbed in the heating and wearing of the friction surfaces instead of being returned to the train, as is the case with spring gears. However, there should be sufficient recoil to release the gears promptly, as some gears have been found jammed and failing to release.

The advocates of increased travel should consider that 150,000 pounds capacity is, in general, sufficient with the present travel when the gear is satisfactorily designed, in view of the fact that the majority of cars with which they run have draft gears of only 60,000 pounds capacity.

No definite figures can be obtained concerning the variation in the cost of maintenance in the draft gear itself comparing the older spring gears with the modern spring and friction types, as the weaker gears, draft attachments and cars themselves are liable to be in more or less worn-out condition. It is found that the modern wooden cars with the improved gears are very seldom shopped for draft gear repairs, but a large proportion of bad order cars are of the older type, and the damage can generally be traced to the weakness of the draft gear. The old single spring having a capacity of often less than half the tractive power of the engine is easily compressed and then transfers hammer-blows to the car framing, resulting in large renewals of springs and attachments.

Renewals to the friction gear have been due to broken casings, springs and occasionally friction blocks, but this breakage has not been a serious factor with the better class of gears, in fact many gears have been found in good condition and with their capacity unimpaired after five or six year's hard service. The breakage of springs is due to heavy loads imposed in a relatively short travel, but even with these springs broken it is found that some friction gears have a capacity equal to that of the twin or tandem spring gears.

The condition of friction draft gears jamming and failing to release is not a general one and has been found in only a few types. The reduction in capacity is due more to broken springs than to wear of the friction surfaces, as it is found in some cases that when the springs are in good shape the old gear has a higher capacity than the new gear, due to the friction surfaces having taken a bearing. The broken casings were found largely in the first gear put on the market and the points of weakness when found were reinforced, so that little difficulty is now experienced in this direction. It is felt that the sticking of gears in compression is due to the combination of insufficient frictional area and too great an angularity in the wedges.

FRICTION DRAFT GEAR TESTS.—To supplement the data furnished by answers received to circular of inquiry relating to a standard maximum capacity and the desirable resistance during each ⅛-inch compression, static tests were made of new and old gears of types most largely found in service. Twenty-seven gears, furnished by different railroads, representing five types, were tested, and of this number nine were new, the others having been in freight car or locomotive service from a few months up to five or more years. Each type is denoted by a letter and

Test No.	Type	Work done inch lbs.	Work absorbed inch lbs.	%	Recoil inch lbs.	%	Gear closed at	Total Deflection
1	A New	163,200	141,000	86.39	22,200	13.61	120,000	2.801
2	A New	104,000	81,200	78.07	22,800	21.93	90,000	2.793
3	A New	122,000	100,600	82.46	21,400	17.54	95,000	2.748
4	A Old	60,000	51,800	86.33	8,200	13.67	60,000	2.361
6	A Old	126,600	109,600	86.57	17,000	13.43	150,000	2.505
8	B New	172,000	154,400	89.76	17,600	10.24	170,000	1.903
9	B Old	102,400	90,800	88.67	11,600	11.33	200,000	1.881
5	B Old	99,000	82,000	82.82	17,000	17.18	110,000	2.243
7	B Old	64,000	47,200	73.75	16,800	26.25	85,000	2.363
14	B Old	232,400	210,600	90.63	21,800	9.37	280,000	2.295
14a	B Old	151,600	129,600	85.49	22,000	14.51	160,000	2.420
15	B Old	162,000	138,600	85.55	23,400	14.45	175,000	2.267
15A	B Old	93,600	75,200	80.34	18,400	19.66	105,000	2.295
12	B_1 New	213,600	191,800	89.79	21,800	10.21	225,000	1.948
12a	B_1 New	159,800	137,600	86.10	22,200	13.90	210,000	1.873
13	B_1 New	302,000	279,200	92.45	22,800	7.55	285,000	2.218
13a	B_1 New	226,600	205,400	90.64	21,200	9.36	235,000	1.708
23	B New	262,200	230,000	87.72	32,200	12.28	280,000	2.283
24	B Old	197,700	165,000	88.23	22,000	11.77	290,000	1.748
25	C New	173,800	144,600	83.20	29,200	16.80	300,000	2.203
26	C Old	44,200	29,800	67.42	14,400	32.58	160,000	2.103
17*	C_1 Old	105,200	81,800	77.75	23,400	22.25	300,000	2.422
18*	C_1 Old	105,200	78,800	74.90	26,400	25.10	300,000	2.477
19*	C_1 Old	91,200	71,600	78.50	19,600	21.50	300,000	2.435
20*	C_1 Old	134,000	118,600	88.52	15,400	11.48	300,000	2.323
21*	C_1 Old	129,800	117,400	90.45	12,400	9.55	265,000	2.340
22*	C_1 Old	102,600	77,000	75.08	25,600	24.92	300,000	2.434
27	D Old	40,000	23,800	59.50	16,200	40.50	300,000	1.449
27a	D Old	65,800	37,800	57.44	28,000	42.56	300,000	2.023
28	D Old	38,000	23,200	61.05	14,000	38.95	300,000	1.185
28a	D Old	64,000	39,600	61.87	24,400	38.13	300,000	1.840
10	E New	145,000	138,400	95.45	6,600	5.55	195,000	3.000
11	E Old	124,600	118,800	95.80	5,200	4.20	130,000	2.812

*- Passenger type. No. 4 had broken preliminary spring.

Note:-
Test No. 12 on type "B_1 New" was very irregular, the wedges frequently sticking in such manner as to cause very severe shocks when finally their resistance had been overcome. In tests 13, 14 and 15 the gears behaved in much the same way. Tests 12a and 13a are retests of gears 12 and 13. No. 12a is made after five additional complete closures of the gear, for the purpose of smoothing the wedges to relieve the irregularities noted in test No. 12. No. 13a was made after eight additional closures of gear No. 13, made for the same purpose as in the case of gear No. 12. In this case the treatment was only partially successful, since the wedges in wearing down to a smooth surface began to score, thus introducing an additional source of irregularity in the behavior of the gear. No. 27 and No. 28 tests were on rusty gears and on this account the friction surfaces failed to operate properly. Nos. 27a and 28a were tests on same gears with friction surfaces greased.

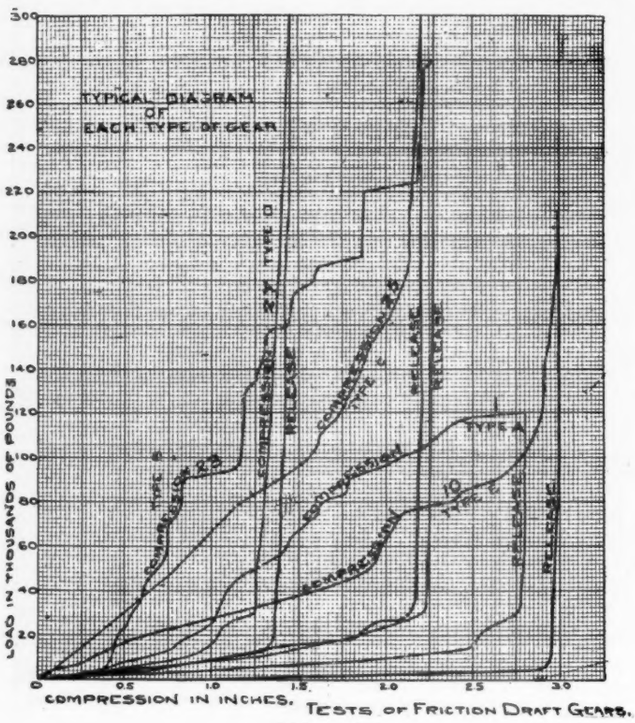
SHEET 16.

in the two types having more than one pattern, the difference is denoted by adding a subscript to the letter. The tests were made on a 300,000-pound screw machine, increments of load being applied in the usual manner and the readings of deflection made until the gear became solid when release was made in increments and corresponding readings taken. These results were plotted, in the usual manner, and computations shown on Sheet 16.

Type "A" is constructed on the parallel friction surface principle, and has been on the market a number of years. Its application is the most extensive of any of the friction gears and it is in general use on a number of roads largely engaged in coal and ore traffic, and has been reported satisfactory. Tests Nos. 1, 2 and 3 are new gears, and 4 and 6 old gears that were on freight cars for a inumber of years. The gear used in test No. 4 had a broken spring, but with this defect the gear had a capacity equal to that of the better type of spring gears with the additional advantage of only 13.67 per cent. recoil. The gear in test No. 6 shows up well for an old gear, and may be accounted for

by the fact that the frictional surfaces had become well worn. This type of gear decreases in efficiency when casings and springs are broken, but the difficulty from the first cause has been reduced by improving the design. As far as can be learned the gears do not become inoperative by becoming jammed and failing to release.

Type "B" is of the angular friction surface type and the new gear has a very irregular compression line largely due to the rough surfaces and the large angle of the wedges. Attention is directed to tests 12, 13, 14 and 15, and to retest of the same gears under numbers 12-A, 13-A, 14-A and 15-A, as shown on Sheet 16. It is seen that the spring action changes to friction action in about .4 inch, and also on comparing the compression



SHEET 14.

with that of the other gears it will be noted that it is extremely abrupt, irregular and less efficient in cushioning the shock on the car framing than the spring action extended over more travel.

The other gears, types C, D and E, are used less extensively than the foregoing ones and little definite information regarding them is available.

Attention is directed to Sheet 14, which shows a typical diagram for each of the gears. It will be seen that there is a wide difference in the distribution of work between the different gears and it is evident that the results obtained in cushioning the shocks will necessarily vary to even a greater extent, due to influences not exhibited by the diagrams, such as wear of friction surfaces, breakage and set of springs and deformed casings.

In view of the above facts, the committee, while admitting the value of static diagrams in determining certain facts about the distribution of work in friction draft gears, feels that at the present time it would be inadvisable to recommend a standard maximum capacity or to specify how it should be distributed. Were these values now specified within narrow limits it is evident that at the best not more than two types of gears would satisfy the requirements imposed.

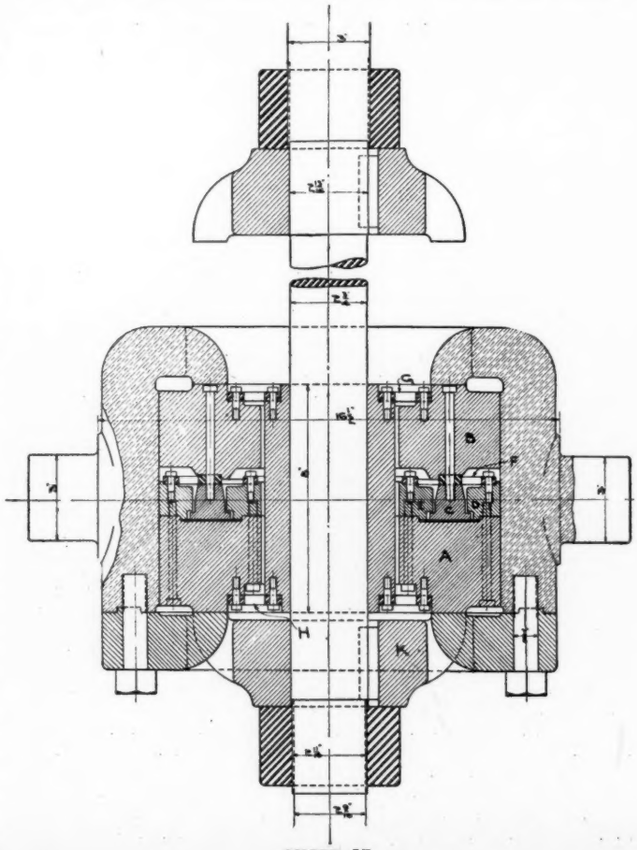
Through the kindness of A. L. Humphrey, general manager of the Westinghouse Air Brake Company, who has devised a method for testing friction draft gears, data of exceeding interest and value has been available. This test consists in dropping a 9,000-pound weight, working between machined guides, a distance varying from 6 to 24 inches. The draft gear is mounted on a standard follower, supported by standard stops secured to channels by eighteen ½-inch rivets. This test gives a general idea of the relative values of the various spring and friction gears in reducing damage to the car framing, due to improper distribution of compression and excessive recoil. Mr. Humphrey has very generously offered to place this apparatus at the disposal of any members of the Association wishing to make draft-gear tests.

The committee has in mind the design of an apparatus embodying something of the above principle, but so arranged as to be applicable to a standard car in order that a close approximation to actual service conditions may be obtained in testing the efficiencies of the various friction draft gears in cushioning the shocks to the car framing. It is also believed that in the event of satisfactory results being obtained from these tests that a standard method of testing friction draft gears may be developed for testing gears on a drop test machine, providing that the conditions on the last mentioned apparatus may be so adjusted as to closely approach those found in the service test, and in this event the test could be incorporated in specifications for friction draft gears, which should be framed as soon as sufficient definite information on the subject has been obtained, and the committee will continue to work along these lines.

COUPLER SIDE CLEARANCE.

As a result of the topical discussion at the 1907 convention on coupler side clearance the executive committee referred this matter to the coupler committee. Railroads who have investigated the subject were requested to send results of their tests, but no data was furnished, as they evidently did not consider these sufficiently thorough to conclusively solve the problem. Several methods of testing were then considered with a view of determining definitely the proper side clearance for couplers on freight equipment cars. No tests have been made, but the following plan is submitted for the consideration of the Association, and it will be carried out during the coming year, if it is approved. A train of steel gondola cars of 41 feet, 11 inches coupled length, equipped with couplers having 5-inch total side clearance, is to be operated on a division having a large number of sharp curves, including some of 13 degrees. By means of iron blocks the side clearance can be adjusted from 0 inch to 5 inches, and it is proposed to measure the lateral stresses exerted by the coupler on the various curves with a recording pressure registering device placed on the end sill of one of the cars. The draw-bar pull for the different side clearances on the curves can be obtained at the same time with a dynamometer car. In this manner the side pressures exerted by the draw bar and the relation of tonnage hauled to coupler side clearance, will be determined. From these results it will be easy to determine whether or not flange wear is increased by limiting the side clearance.

Through the courtesy of A. S. Vogt, mechanical engineer of the Pennsylvania Railroad, and Messrs. William Sellers & Co., Engineers, a drawing of a proposed hydraulic side pressure dynamometer is shown on Sheet 17. The principle of the device is as follows: A single annular diaphragm is used, which is clamped between pieces "A," "D" and "E," and which is loaded by piece "C," which in its turn is attached to piece "B." All of these pieces are in the form of rings. The parts are stayed by thin plates "F," "G" and "H," which are also in the form of rings. The cell is enclosed in a shell fitted with trunnions, and having radial finger-like projections at each end, which form the abutments. The washers, or followers, "I" and "K," are made with similar projections so as to transmit the load to the support. The liquid is confined between the diaphragm and the recess in



SHEET 17.

"A," and this space is connected by means of a small copper pipe to a recording gauge of the Bourdon tube type. The attachment to the coupler and car is shown on Sheet 18 (not reproduced). The desired side clearance can be adjusted by placing blocks inside the yoke connecting the registering device to the coupler. As the space containing the liquid is very small the travel of the piston and consequent lateral play of the coupler beyond the desired clearance will be practically negligible. The calibrations will be made from an initial pressure to avoid any errors due to lost motion. The question of purchase of this dynamometer at the expense of the Association has been referred to the executive committee, and if approved, the committee hopes to furnish some definite data on this subject next year.

ATTACHMENT OF YOKE TO BUTT.

There is some dissatisfaction with the present method of attaching coupler yokes to the butts, but to date no other method has been presented which, in the judgment of the committee, would be an improvement. It has been suggested that additional lugs be cast on the coupler shank to form a pocket for the yoke gibs between these lugs and the coupler butt. The object of the extra lugs is to force the yoke gibs to fit against the coupler butt and thereby avoid placing the rivets in shear. Your committee assumes that it is expected to deal with couplers without machining and to use yokes as they are forged, which necessarily means some allowance from the drawing sizes. The pocket formed on the coupler shank, unless machined, will not be accurate, which also holds true in the case of the gibs on the coupler yoke. Even with good machining it is difficult to obtain fits of one yoke gib in the pocket, and this difficulty is increased as the two gibs of the yoke must be fitted at the same time. If any motion is allowed, to that extent the rivets are subject to shear, and practical application with any workmanship that is likely to be secured within reasonable cost will result in a certain amount of clearance between the yoke and lugs, however placed, and the stress will be placed upon the rivets until such time as they are worn or sheared enough to allow all parts to come into bearing.

Another suggestion is the use of four short rivets instead of two long rivets, the idea being that the short rivets can be better heated so as to completely fill the hole when driven. Experiments have been made along this line, but no decided advantage to offset the additional cost was found. The present standard providing for 1¾-inch bearing top and bottom for the rivets is a decided improvement over the old design of butts, and the main difficulty at the present time is the relatively poor fit of the yoke to butt and the membering of the rivet holes. If more care is exercised in this fitting it will greatly increase the efficiency of the attachment. To further this end the committee is designing gauges for the relative location of the rivet holes to the gib bearing surface on the butt and the similar spacing on the yoke. It is believed, however, that the rivet holes in the butts should be drilled or broached to insure better fitting of rivets, and the committee, therefore, makes this recommendation.

Standard Marking of Freight Equipment Cars.

Committee—R. L. Kleine, chairman; T. H. Russum, W. O. Thompson, C. B. Young, J. F. Dunn.

At the last convention the committee on standards and recommended practice presented a communication from Mr. W. F. Allen, Secretary of American Railway Association, relative to recommendations from Mr. Arthur Hale, chairman of the American Railway Clearing House, in regard to marking cars with standard initials and the suggestion that the initials and numbers should be painted in some uniform place on each car, and not too high. It was also stated that Mr. Hale had taken up the subject of standard initials for marking freight cars with the Association of Transportation and Car Accounting Officers.

The object of this suggestion is to facilitate car checking, particularly at night, the intention being to recommend a uniform location and height for the initials and numbers of cars, and with this understanding the suggestion was approved by the committee on standards, which offered the following additional paragraphs to the section on stenciling cars:

"The initials and numbers of all cars having a superstructure, which will permit, shall be placed about midway between the door and corner post on the left-hand side of the car, and be arranged at a height of 4 feet 9 inches from the rail to the underside of the bottom row.

"It is further recommended that the name of the railroad should also be placed on this end of the car over the initials and number, and that the space at the right-hand end of the side of the car be reserved for the marking showing capacity, dimensions, weight, etc."

In view of the various standards of marking in use by the railroads, many of which possess points of merit, and the fact that the construction of the cars regulates to some extent the location of the marking, the committee is of the opinion that the location of the marking should not be confined within narrow limits, but a recommended practice governing it should allow sufficient latitude to meet conditions and at the same time confine the location so that it will facilitate the work of car checkers, conductors, scale men, inspectors, and others, whose duty it is to take information from markings on cars.

Although the work assigned to the committee was to consider the location of the initials and numbers of cars, it was found that the locations of other markings were so closely allied to those of the initials and number that they have also been included, subject to approval.

With this end in view, the committee submits the following recommendations for consideration:

MARKING ON FREIGHT EQUIPMENT CARS.

1. Freight equipment cars that have a superstructure which will permit should be stenciled with markings on sides of car, in the following order:

Lettering (Initials or Name of Road),
Number,
Capacity,
Light Weight.

This marking is to be located as nearly over the truck as the lettering will permit, preferably to the left of center line of side of car. On box and other house cars where doors slide to the left, the above marking may be placed to the right of center line of side of car. On any other cars where the construction makes it necessary, this marking may be placed either to the right of center line of side of car, or in the center of side of car. The distance from the center line of coupler to the bottom of car number to be normally 2 feet 4½ inches, with a minimum dimension of 1 foot 10½ inches, and a maximum of 2 feet 10½ inches. The spacing of the remaining marking to be as shown on diagram. (Not reproduced.)

This location will place all the information necessary for the ordinary handling of cars in yards, freight sheds and over scales, in such a position that it can be easily read, both day and night, from the ground, platform, or scale, by conductors, scale men, car checkers, inspectors, agents and any other men whose duty it is to take information from markings on cars.

By placing the light weight below the capacity, it will facilitate restenciling this information when necessary at times of reweighing. Space should be left between the light weight marking and the bottom of car side to allow for restenciling at time of reweighing, as it is impracticable to stencil over the old marks without giving time for body color paint to dry.

In order that the markings may be most effective, the committee suggests the use of 9-inch letters for the name or initials, 7-inch figures for the number, 3-inch letters and numbers for the capacity and 4-inch letters and numbers for the light weight as preferable sizes for this lettering and numbering, although the alternate sizes now given in recommended practice may be used if desired.

2. The ends to show the initials or name of road, car number and light weight, in the upper half of end of car. On box or other house cars having end doors, this lettering should be so located that it will not be obscured when doors are open.

The upper half of end is preferable, as the lower half is more frequently covered by dirt and grease thrown upward by the wheels of the preceding car, which would obscure the marking if placed on this half of car end, and in case it is necessary for a conductor to take any numbers while train is in motion, they can be much more readily seen from the top of car.

The initials, number and light weight on end of car are of paramount importance to scale men, as it enables them to compare the initials and number with the manifest and enter the light weight before the car reaches the scale platform, besides assisting the weigher to set the scales.

3. Flat and low sided gondola cars should show the lettering (initials or name of road), number, capacity and light weight on the side of car in the best available location offered by the construction of the car. Suggestions as to the arrangement of this lettering are shown in the diagrams. (Not reproduced.) When possible, the sizes of lettering and figures should correspond with those used on other freight equipment cars. The end marking on flat cars may be omitted.

It is self-evident that no specific recommendations in regard to location of lettering on flat and low-sided gondola cars can be made, due to the limited available space upon which to place the lettering, in addition to the variation in construction, and it was thought desirable to only specify that the necessary markings should be placed upon the cars leaving the location optional, so that it can be best suited to the construction.

4. Side and end doors should be stenciled with the initials or name of road either on the outside or inside of door. If placed on the inside the stenciling should be so located that it will not be defaced by the sliding of the door.

This stenciling is considered essential to enable railroads to determine the ownership of doors which are lost off.

If the above recommendations meet with approval the present recommended practice relating to the "marking of fast freight line cars" should be dropped, as the proposed arrangement covers all cars.

The committee on standard and recommended practice re-

ferred the three following suggestions, received from members in regard to changes in standards relating to marking of freight equipment cars, to this committee for consideration, and it would report as follows:

STANDARDS FOR STENCILING CARS.

1. It is recommended to discontinue stenciling the words "air brake" on cars, since all cars must be so equipped.

The committee approves of this, inasmuch as the Rules of Interchange provide that "All cars offered in interchange must be equipped with air brakes," and, therefore, the stenciling of air brake on the cars has become obsolete, and we would suggest that this portion of paragraph be dropped from the Standards.

2. It is recommended to omit legend "Do not nail this door," as it is not observed, and, therefore, has no practical value.

While the committee agrees with the suggestion that this is of no practical value, there is nothing in the standards or recommended practice requiring stenciling of car doors "Do not nail this door," and, therefore, has no recommendations to make.

3. It is recommended to eliminate stenciling "A" and "B" end on cars, as it is unnecessary.

The committee approves of this suggestion, inasmuch as the location of brake shaft indicates the ends of car which are equipped with one brake shaft; and the direction in which the push rod travels distinguishes the ends of the cars which are equipped with two brake shafts. Railroads should not be required to place any more stenciling on cars than is absolutely necessary, not so much from the standpoint of first cost as the expense involved in maintaining same.

The committee would call attention to the elaborate advertising on the sides and ends of some cars and would recommend that the practice be discouraged, as it very often involves employing experts in freight repair shops to reproduce the original intricate designs when repairs to siding are necessary.

Pedestals and Journal Boxes for Passenger Cars.

Committee—C. A. Seley (chairman), E. A. Benson, J. J. Tatum.

At the 1907 convention the committee on standards and recommended practice made the following report on the above subject:

"Your committee believes that this box and pedestal could be improved by being made nine inches in width, and suggests that it be referred to a special committee to make recommendations and propose designs."

This has special reference to the pedestal and box for 5 by 9 journal shown on M. C. B. Sheets C and E. The present outside width of the box between the pedestal fits is 8½ inches, which gives but 7½ inches inside width between walls, ½ inch less than on the freight car box of same size. This restricts convenient handling of the sponging, bearing and key, as well as giving too little room for using oil cans.

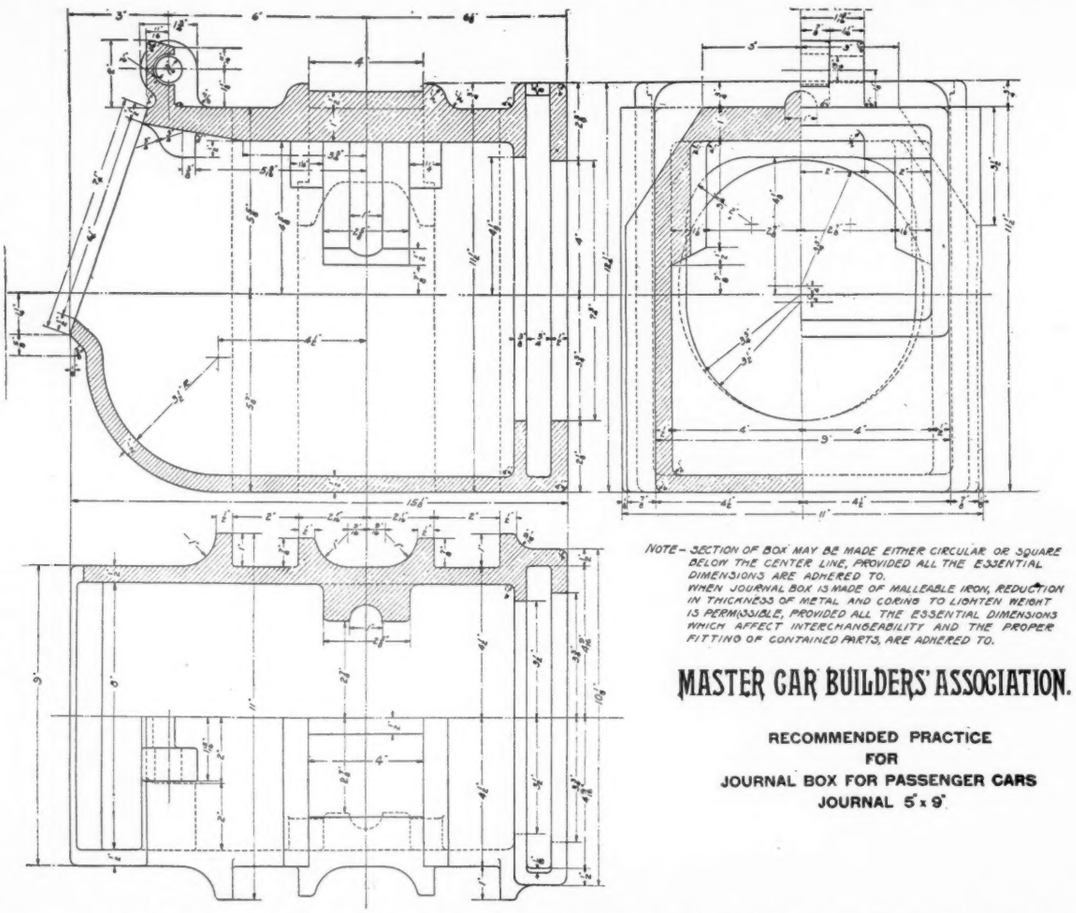
The committee, therefore, presents for consideration a new drawing of the 5 by 9 passenger box, revised from that shown on M. C. B. Sheet C, with dimensions changed to give 8 inches inside width between walls, preserving other essential dimensions.

The drawing presented also includes some other revisions which the committee deems advisable.

Sheet M. C. B.—C shows the top corners of the box chamfered, no dimensions being given. This is for clearance of the equalizer, and the amount of chamfer has been increased both in length and depth to permit stronger equalizer construction.

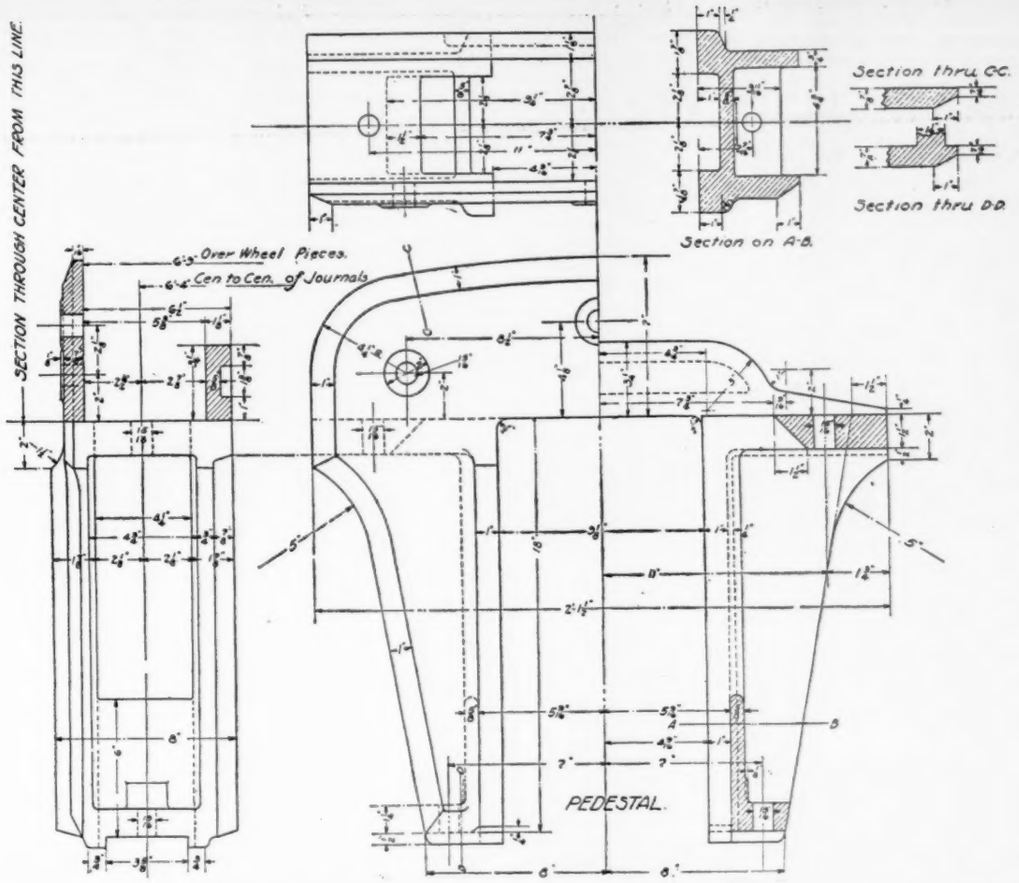
The drawing has also had the end view corrected to show the bottom edge of the lid opening level to agree with the other two views, as well as to make the lid opening of the same shape on all the freight and passenger boxes.

Slightly increasing the clearance between the outside dust guard wall and axle is suggested, and in doing so the depth of the box for oil has only been decreased 1-16 inch. The opening for the dust guard has been therefore increased a like amount to maintain the lap of dust guard on wall, thus better preventing dust getting into the box. The inner dust guard wall has been considerably modified in order to clear the flanges of the journal bearing, but it has been sufficiently retained to strengthen the box at the upper corners.


NOTE—SECTION OF BOX MAY BE MADE EITHER CIRCULAR OR SQUARE BELOW THE CENTER LINE, PROVIDED ALL THE ESSENTIAL DIMENSIONS ARE ADHERED TO.
WHEN JOURNAL BOX IS MADE OF MALLEABLE IRON, REDUCTION IN THICKNESS OF METAL AND CORING TO LIGHTEN WEIGHT IS PERMISSIBLE, PROVIDED ALL THE ESSENTIAL DIMENSIONS WHICH AFFECT INTERCHANGEABILITY AND THE PROPER FITTING OF CONTAINED PARTS, ARE ADHERED TO.
MASTER CAR BUILDERS' ASSOCIATION.
RECOMMENDED PRACTICE
FOR
JOURNAL BOX FOR PASSENGER CARS
JOURNAL 5" x 9"

The committee also offers for approval a new drawing of pedestal for 5 by 9 boxes revised from that shown on Sheet M. C. B.—E increased in width between the jaws from 8⅝ inches to 9⅛ inches to take the box just described, also having revised the location of one of the bolt holes by which the pedestal is bolted to truck wheel pieces in accordance with the practice of some of the larger companies.

We find that many trucks are in use having width over wheel pieces not the same as called for on the drawing, so that offset of bolting flange is not much value as a standard, and as it would complicate the drawing so much to show the offset required for various widths, it is deemed not desirable to make any change in this respect. The spacing of the bolt holes at the bottom which are used for bolting the tie bar has been increased, so as to use square-head bolts. The present spacing necessitates the use of T-head bolts, which are special and not generally as available as square-head bolts.



The committee also suggests removal of the bead or surface ribbing, making the outer face of the pedestal one continuous surface, of proper thickness at the bolt holes and guides and gradually rounding off to the outer edges. This modification does not sacrifice strength nor materially increase the weight, but it does improve the appearance and facilitates cleanliness. The smoother surface does not catch and retain the dirt as on present design, and is more readily wiped.

This drawing shows wearing bearing, as formerly, for 1-inch depth of flanges on boxes.

This committee was also instructed to include in its recommendations designs for journal box and pedestal for trucks using 5½ by 10 inch journals. It does not favor the use of this size journals in passenger service. They are not justified in six-wheel trucks, and when cars are of the length and weight which would require greater axle capacity than is afforded by four with 5 by 9 inch journals, six-wheel trucks should be used.

It finds that very few roads have used 5½ by 10-inch journals in passenger service. If future development should bring about such a requirement, it is of the opinion that by that time the truck construction and material will have changed from present practice and the labor would be in vain, at least so far as the pedestals are concerned.

Side Bearings and Center Plates for Freight and Passenger Cars.

Committee—R. D. Smith, chairman; R. P. C. Sanderson, Alfred Lovell, J. H. Manning.

The committee was instructed:

To review and give synopsis of reports on side bearings and center plates made to the Association in the past, since and including 1900.

To recommend a standard spread, height and clearance for side bearings for freight and passenger cars.

To investigate and report on the relations which center plates and side bearings may bear to derailments.

The first step taken by the committee was to carry out the instructions of the executive committee, to review the previous reports on center plates and side bearings, and a synopsis of the reports presented to the 1900-1-2-3-4 conventions was given.

RECOMMENDATIONS.

Friction should be reduced as much as possible, and as hardness and rigidity of form have a direct bearing on this, and ample strength being important, the committee recommends the use of cast steel center plates for large capacity cars and malleable iron or cast steel center plates for smaller capacity cars.

The committee believes that it is desirable to lubricate ordinary center plates and recommends that this be done at frequent intervals.

Taking into consideration the information which has been received as to the durability of anti-friction center-plates, the committee cannot now recommend their use as the standard practice of the Association, but considers further investigation desirable.

While the resistance of the trucks to turning might perhaps be reduced by placing the side bearings nearer to the center plate than is the common practice, the tendency of the car to roll would be increased.

The committee recommends adopting as standard for passenger cars:

A spread of 88½ inches center to center of side bearings on six-wheel passenger car trucks with outside bearings. A spread of 60 inches center to center of side bearings on four-wheel passenger car trucks. That side bearings on passenger cars be placed just in contact, but carry no load.

The various designs of trucks and bolsters in use, and the tendency to use steel construction, make it impracticable to recommend standard heights of side bearings or their height relative to the height of the center plate on passenger cars.

The committee recommends adopting as standard for freight cars:

A spread of 60 inches center to center of side bearings. A clearance of not less than ¼ of an inch nor more than ⅜ of an inch between upper and lower side bearings when new.

The various designs of trucks, bolsters and steel underframe constructions in use make it impracticable to recommend standard heights of side bearings or their height relative to the height of the center plate.

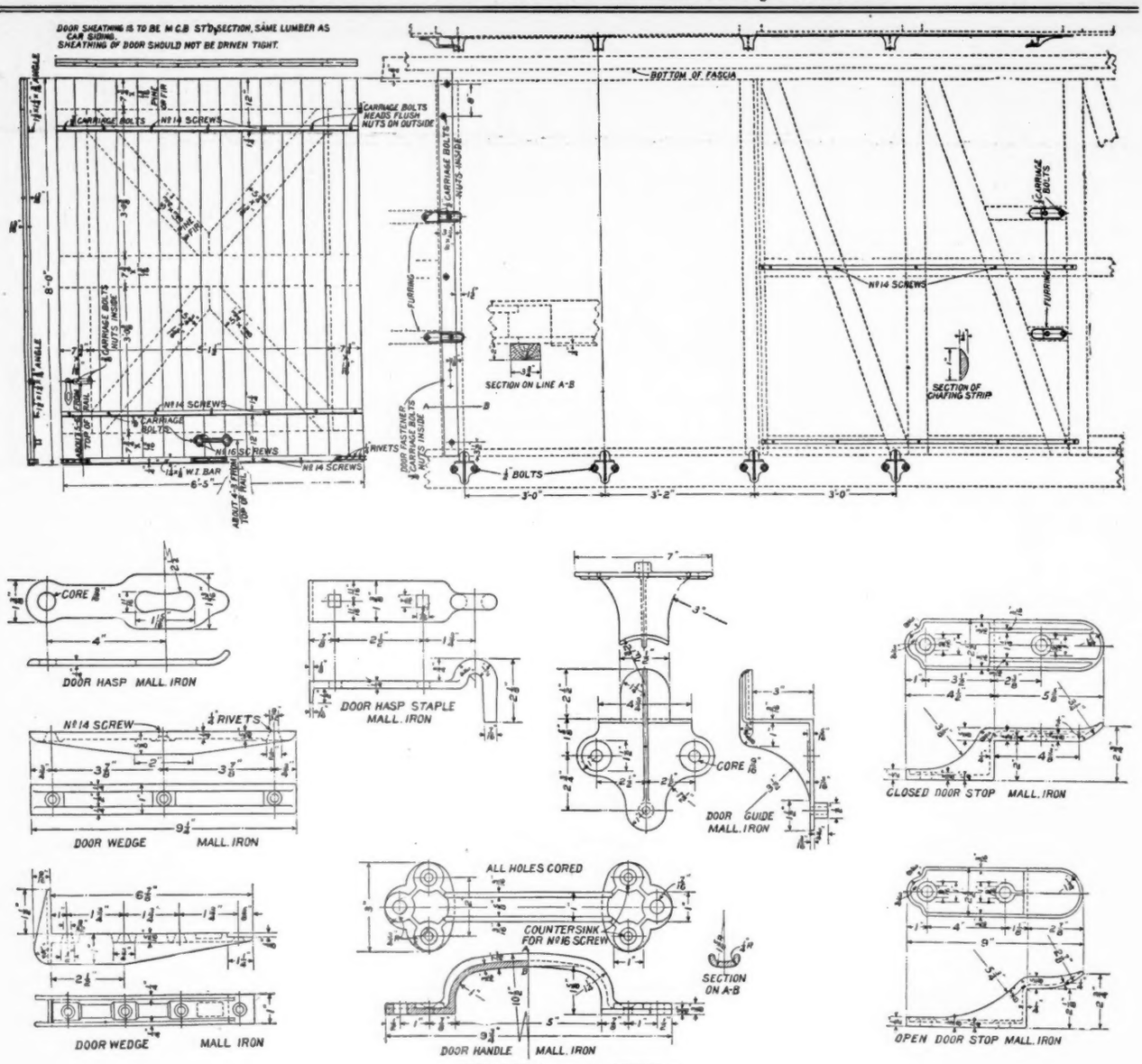
The investigations of the committee warrant them in stating that the use of anti-friction side bearings will reduce flange wear and lessen the probability of derailment.

As it is not proper to recommend as a standard any specific patented device, the committee recommends only, for passenger and heavy capacity freight cars, the use of side bearings embodying the anti-friction principle in any form that insures simplicity and durability to the greatest possible extent.

In view of the importance of tests to be recommended later, the committee does not suggest any change in the M. C. B. standard center plate.

There is evidence that derailments have in many instances resulted from the use of side bearings carrying too great a proportion of the load when used with rigid underframes, and from the binding of improperly constructed center plates and side bearings, which causes the wheel flanges to crowd and climb the rail.

The greatest practical freedom of movement of the trucks



PROPOSED M. C. B. SHEET F.

which allows of their adjusting themselves to curvature and inequality of track is believed by the committee to be of vital importance, not only because there is less probability of derailment, but also because wheel flange wear and the danger from broken wheels is diminished.

The committee therefore calls attention to the importance of this matter and recommends that an appropriation be made for the purpose of conducting further tests, not only of various forms of common center plates and side bearings, but also of different types of anti-friction center plates and side bearings. Tests should be made for the purpose of determining the best location of side bearings.

MINORITY REPORT.

While recognizing the desirability of fixing uniform dimensions for as many parts of cars as possible, I cannot agree to subscribe to the above report, in so far as fixing the distance from center to center of side bearings at 60 inches for freight cars, when the investigation of the committee shows that freight cars are in existence having side bearings located from 48 inches center to center, to 70 inches center to center.

To definitely fix the location of side bearings would, in my opinion, require more time and investigation than the committee has had opportunity to make since the last convention. I have been unable to find that a spread of 60 inches is preferable to a spread of either 48 inches or 70 inches.

D. F. CRAWFORD.

Location of Ends of Running Boards.

Committee—E. A. Miller, chairman; T. A. Treleaven, R. H. Parks, F. W. Chaffee, J. Coleman.

During the year past valuable data has been accumulated and considerable correspondence has been carried on with the members. As difficulty has been found in reconciling the diverging views as to the maximum and minimum allowable projection of running boards, the committee recommends that it be continued for another year, to give the subject further consideration.

Box Car Doors and Fixtures.

Committee—C. S. Morse, chairman; J. A. McRae, O. M. Stimson, J. P. Young, W. Percy.

The committee has made a new drawing for M. C. B. Sheet F, which shows a side door, door stops, bottom guides, chafing strips, wedges, hasp, hasp holder and handle; also, the location of the door stops, guides and chafing strip.

The door has been designed for an opening six feet wide, and height suitable for a car of the inside dimensions approved by the American Railway Association and the recommended practice of the M. C. B. Association. The sheathing of the door should not be driven tight, in order to prevent warping as much as possible.

The closed door stop should be of wood 3¾ inches wide, secured by six ½-inch bolts. The bolts should be staggered to prevent splitting the wood. There should also be at least two metal closed door stops, each secured with two ½-inch bolts with furring under the sheathing.

The door stops for the open door position should be at least two in number and provided with lips. Each stop should be secured with not less than two ½-inch bolts, with furring under the sheathing, unless posts or girths are available.

There should be two 1-inch half-oval chafing strips to protect the sheathing back of the door when open; one strip located near the bottom and the other at about one-half the height of the door.

There should be at least four bottom guides, located so that not less than two guides will engage the door in any position. Each guide should be secured to the sill of the car by at least two ½-inch bolts. The bolts for the guide at rear corner of door in closed position should have the nuts riveted over or bolts locked in other suitable manner.

The door hasp staple should be secured with two ⅜-inch carriage bolts, with the nuts inside and a washer under the nuts. The frame should be counterbored for the thickness of the nuts. The door hasp fastener should be secured with not less than two ⅜-inch bolts, with the nuts inside, and it is recommended that the fastener have a flange that will lip over the back of the wooden door stop. The door hasp fastener is a specialty which is usually purchased from manufacturers, therefore no drawing has been made.

The use of door hangers of patented designs has become almost universal, therefore it does not seem desirable to attempt to show a design for them. Each door hanger should be secured with not less than three bolts at least ⅜-inch diameter with nuts outside.

The track for the door hangers should be of some standard structural steel shape at least 3-16 inch thick, which is readily procurable on the market. The track should serve the double purpose of a runway for the hangers and a weather proof and spark proof door hood. The track should also be arranged so that the door cannot drop off if the hangers are broken.

End doors are not generally used on box cars, therefore the end door and fixtures for them have been omitted.

Protective Coatings for Steel Cars.

Committee—G. E. Carson, chairman; T. Rumney, S. A. Cromwell.

The committee at this time has some few cars under test, as follows:

One car covered with a coating of crude petroleum oil;

One car painted with special black paint and covered with a coating of good fish oil;

One car painted with special black paint and covered with a coating of locomotive cylinder oil;

One car painted with common paint and covered with equal parts of raw linseed oil and pure glycerin;

One car painted wth common paint and covered with Cleanola;

One car painted with common paint and covered with well-rubbed-in commercial tallow.

All of the above cars were sprayed on the inside with crude petroleum oil.

Following are the recommendations as far as the committee has gone:

Suitable buildings should be provided for the painting of cars, so that the painting of the equipment would not necessarily be confined to certain seasons of the year.

In the preparation of the assembled parts of new cars, they should not be exposed to the weather or permitted to rust before their assemblage. In all cases where metal is placed against metal, either riveted or bolted, it should be free from flash or rust and covered with one or two coats of red lead, and the mixture be heavy enough to exclude moisture. But this precaution will avail little unless extra care is taken that all the steel parts fit evenly.

After cars are ready for the first coating, it is necessary that all flash and rust be removed. This should be done under rigid inspection. Unless the flash is removed it will invariably begin to fall off inside of a year and continue as long as any remains, regardless of the number of coats of paint applied. It is recommended that all flash and rust be removed by sand blast, where possible. Dry cleaning (which is not as satisfactory) is also recommended by using steel scratch brushes, sandstone, or any tools which will answer the purpose, being particular to remove all the dust with suitable brushes or dusters. After following either of these cleanings, the application of three coats of paint at twenty-four-hour intervals is suggested.

In the preparation of cars for repainting, cleaning by sand blast is recommended, but if this cannot be done, then use the dry-cleaning process, as previously mentioned. After the dry cleaning, two coats of standard paint should be applied at twenty-four-hour intervals.

After taking all these precautions to protect the outside of the car, under ordinary conditions it is necessary to repaint at the expiration of three years, and where conditions are unfavorable to the equipment it will be necessary to repaint oftener.

The committee cannot be too emphatic as to the necessity of taking the proper care of the exterior, and regrets not being able to give the interior equal care.

The best of paint should be used in order to prevent rust after painting, and by using paint which has the greatest wearing elasticity, the less liability there is for the penetration of moisture. Adhesion is just as important, and to have perfect adhesion, the paint should dry from the inside out, the same as good varnish.

Elasticity must also be considered, for where adhesion is perfect and no elasticity in the materials, we cannot hope for good results. For the reason that expansion and contraction of the plates must be provided for, the use of linseed oil or its equivalent is preferred.

The painting of the inside of steel cars has been thought by some to be beneficial, but the committee can see no lasting benefits in this, and do not recommend it, but is of the opinion that coating the interior of the cars about once every six months with black oil would act as a preservative.

Further than this the committee is not able to offer any recommendations, and asks to be continued for another year in order to determine the results of the tests which are being made.

Triple Valve Tests.

Committee—A. J. Cota, chairman; R. K. Reading, E. W. Pratt, F. H. Scheffer, D. C. Ross.

The committee reported that the new 100-car, 10-inch, brake-cylinder testing rack has been built and shipped to Purdue University at Lafayette, Indiana, and that the material is now stored awaiting the completion of a room that is being especially built for housing the test rack. This building will be completed about June 20.

Journals on Standard Axles.

The topical discussion on the question: "Should journals of standard axles when fillets are partially worn, be made longer in order to get in a full size fillet? If so, what should be the limit of the length of journals?" was opened by W. E. Fowler (Can. Pac.) as follows:

"There are very few iron axles put under modern freight cars. The axle of to-day is that made of open hearth steel, a material which does not give good service in carrying heavy loads, or in sustaining severe shocks if its outline be disposed into sharp corners or angles, and the designers of the M. C. B. standard axles accordingly have provided, that, where there is a step or change of diameter, there should be a fillet or curved graduated connection between the larger and smaller diameters, since if a sharp corner or right angle be allowed, a fracture is invited at that point, and a great loss of property will probably ensue.

"The lengthening of journals of axles in order to replace worn fillets is a practice which is more or less followed on all railroads, but so far as my knowledge extends, there are no generally observed limits to this extension of length. In my opinion an axle with the journal fillet entirely worn out should, when withdrawn for changing wheels, be scraped. The reformation of the entire fillet with the consequent lengthening of the journal, is an unsafe practice, as when the fillet is quite worn out there is, in all probability, an incipient crack where the fillet formerly was, and it is only inviting trouble to return such axles to service.

"Considering the disastrous results that follow a broken journal, I think "an ounce of prevention is worth a pound of cure" in this as in many other cases, and the prevention consists in scrapping all axles with worn out fillets.

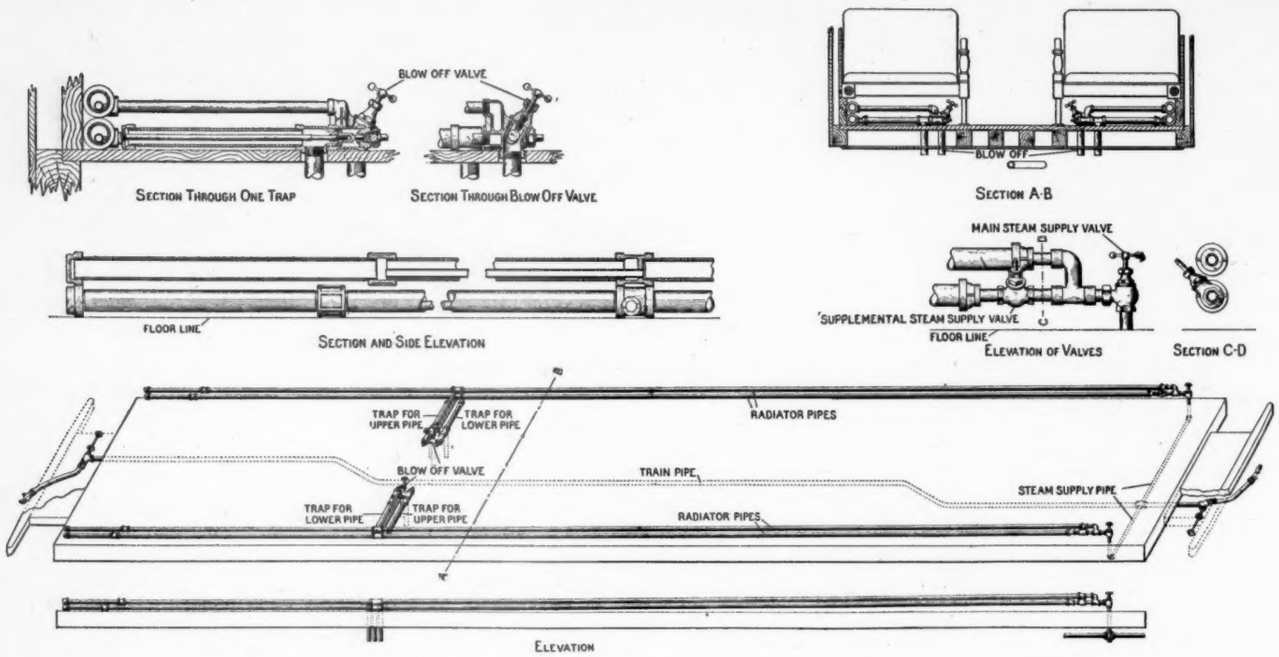
"There are, however, many axles drawn from service on account of wheel failures that have fillets partially worn, and which may in the opinion of many be made fit for long further service by putting them in the lathe and lengthening back the dust guard shoulder and so renew the fillet, so essential to the load carrying ability of the journal.

"I think it will be agreed generally that excessive lateral movement of the journal bearing on the journal (which, of course, means also movement of the superimposed load) is not desirable, in fact, that it is injurious to wheels, axle, and truck, car body and track, and in view of the heavy loads now carried, the speed attained and the consequent stresses on the wheel flange, we should make our wear limits less and our inspection more rigid, to preserve the same factor of safety with the heavy capacity car and the high speed that we formerly had with the light car and low speed.

"We have limits of diameter for journals, wheel seats and axle centers, we have limits for thickness of collars, and we should have limits for length of standard journals, for the reasons enumerated, as also to keep within reasonable limits the lateral movement of journal bearings (and consequently the truck frame) on the journals.

"In view of my opinion that only partially worn fillets should be reformed by lengthening the journal, I think that a length limit of 7½ inches should be set for 7-inch journals, 8½ inches for 8-inch journals, and 9½ inches for 9-inch journals, and 10½ inches for 10-inch journals."

Mr. Hennessey agreed with Mr. Fowler and on a motion by Mr. Forsyth the subject was referred to the committee on standards.



REGULATING DIRECT STEAM HEATING SYSTEM

The Safety Car Heating & Lighting Company has developed a regulating system of direct steam heating to meet the desire of railroads for a steam heating system which is capable of easy adjustment to meet the varying conditions of outside temperature. The most practicable method of accomplishing this result is by so arranging the system that the amount of radiating pipe in service may be varied at will. It is not possible to secure the best results by maintaining a constant radiating surface and varying the steam pressure, as there is not sufficient difference in its tendency to heat the surrounding air between a pipe containing steam at say 45 pounds (290 degrees Fahr.) and one at 2 pounds pressure (218 degrees Fahr.). This allows a possible reduction in temperature of the radiating pipes of 72 degrees, or but 25 per cent. Neither can this result be accomplished by maintaining steam in the radiators at atmospheric pressure, as it is then neither possible to increase nor diminish the temperature of the radiators, and no control whatever is had of the amount of heat delivered to the car.

In this new arrangement there are a total of four radiating pipes running the length of the car, two being located on each side, and each pipe being supplied with independent admission valve and automatic trap for taking care of the water of condensation. It is thus possible to use either one, two, three or four pipes, at a time; or, considering four pipes as the maximum, to reduce the heating effect either 25, 50, or 75 per cent., as may be desired.

The live steam is taken from the train pipe by means of a cross, and passes through a 1" pipe to admission valves located on opposite sides of the car. When both these valves and supplementary valves in the lower radiating pipe are opened wide. steam will enter both the upper and lower pipes of the system, and the maximum heating effect will be obtained. The supplementary valve, which controls the lower pipe, is arranged to be operated by a key or wrench, the object being to keep this valve closed the greater part of the time, thus avoiding overheating the car. This will also very materially assist in preventing the rear cars from being robbed of steam when first heating up long trains. In very cold weather, however, if more radiating surface is desired, this valve is opened on either one or both sides of the car.

It will be readily appreciated that the use of this system will not only result in a substantial saving in steam consumption while the car is in actual service, but will also considerably reduce the cost of keeping cars warm at terminals and yards, as ordinarily a car which is not moving and whose doors, windows and ventilators are closed may be kept sufficiently warmed by the use of but one of the four radiating pipes, with a consequent saving in the amount of steam consumed.

CONSTRUCTION.

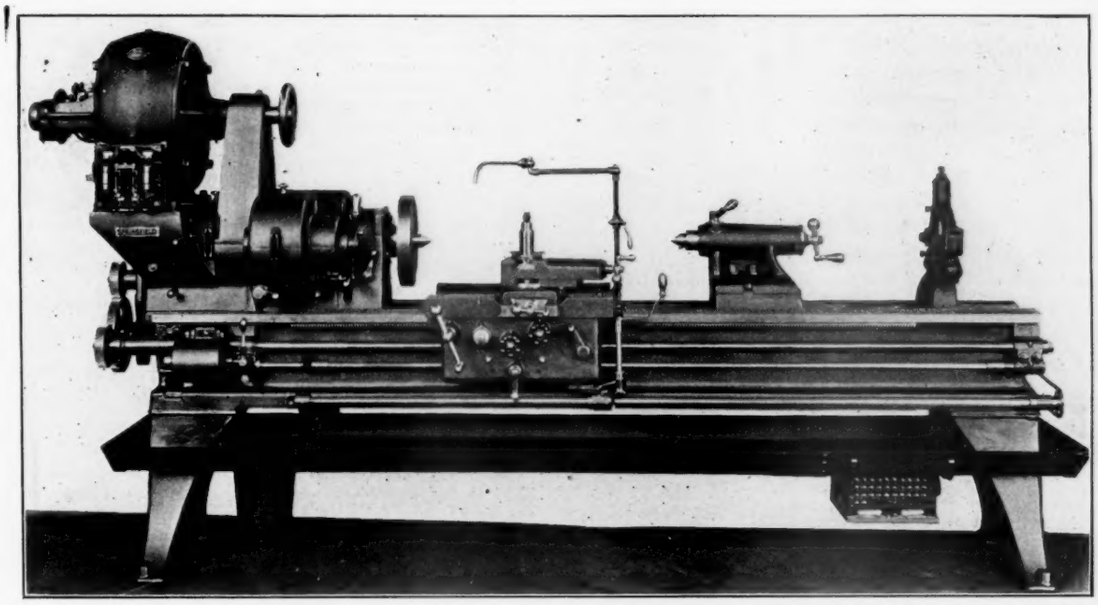
At a point about two-thirds the length of the car from the steam inlet, a special 2" x 1" eccentric tee is located in each radiating pipe. This tee is cast with a vertical web or wall in which are two openings, one tapped with ¾" pipe thread and the other being a small hole for the purpose of facilitating drainage. A ¾" pipe which is screwed into the larger opening lays along the bottom of the 2" radiating pipe and extends to a coupling located a few feet from the end of the 2" pipe. One-inch pipes connect these special tees with fitting, in which are incorporated a blow-off valve and two horizontal traps, and constructed in such a manner that each of the 1" pipes is independently connected through a separate passage with its corresponding trap. The blow-off valve is so arranged that it may be used to operate both the upper and lower pipes. Into the outlet of each trap and of the blow-off valve is screwed a 1½" drain pipe, passing down through the car floor.

In order to understand the operation of this system, suppose all valves to be closed. Now, if either of the main admission valves be opened, steam will enter and pass along the upper 2" radiating pipe on one side of the car until it reaches the special tee. It will then pass through the ¾" pipe (which is introduced to prevent air being pocketed in the dead end of the radiator), expand and fill the remainder of the 2" pipe, and pass through the 1" connection to the inlet of one of the automatic traps. This trap consists of a brass pipe extending horizontally nearly to the radiator and containing a small iron rod permanently attached to one end of the brass pipe, the other end being free to slide and carrying an adjustable disc which seats against the end of the brass pipe. When the car is first put into service, this trap is opened wide and steam allowed to blow through it until it is thoroughly hot. It is then closed by turning up the projecting stem with a key or wrench and permanently securing it by means of a locknut. Thereafter the trap will require no further adjustment, as, on account of the difference in contraction or expansion between the iron rod carrying the valve disc and its surrounding brass pipe, the valve will tend to open when the trap cools, or close when it becomes warmer, thus automatically allowing the water of condensation but no steam, to pass out through the drain pipe.

It will be noted that the traps are adjusted and the entire system operated from within the car, making it unnecessary to get under the car for any purpose.

The operation of each of the other three radiating pipes is, of course, identical with that of the one referred to, and any of the radiators may be turned on or off at will without the necessity of touching the traps or blow-off valves in any way.

On account of the traps being wholly within the car, it is practically impossible for them to freeze; but even should either of them become frozen after steam has been cut off from the car, it could still be readily thawed out by simply turning steam on the remaining pipes.



SPRINGFIELD RAPID REDUCTION LATHE.

HIGH POWER RAPID REDUCTION LATHE.

A recent design of the No. 3, 19-inch, high power, rapid reduction lathe, motor driven, made by the Springfield Machine Tool Company, Springfield, O., is shown in the illustration above. To obviate the heavy and cumbersome construction which would be necessary to make the proper reduction, between the motor and spindle speeds, through gearing, a silent chain is used. The motor shown is of the variable speed type—500 to 1,000 r. p. m. —and has a capacity of 7½ h.p.

The higher spindle speeds are obtained by driving the spindle direct from the motor. The intermediate speeds are obtained through a train of gears consisting of one set of spur and one set of spiral gears. The use of spiral gears makes it possible to turn out work with a very fine finish. The slow speeds are obtained through a double set of back gears. The mechanical speed changes are made by positive steel clutches so arranged that the machine does not have to come to a dead stop before the changes can be made. The motor driven lathe provides for a variation of spindle speed ranging from 10 to 285 r. p. m. The same lathe, belt driven, has ten mechanical changes of speed, and with a two-speed countershaft is designed to give a cutting speed of 80 ft. per minute for diameters from 1½ to 18½ in. The motor controller is placed at the rear of the bed and is operated by the handle shown to the right of the carriage.

The head is heavily ribbed and tied together at all points where it is liable to heavy strains. The spindle is extra heavy and runs in large journals of lumen bearing metal. The spindle and back shaft journals are oiled by babbit rings of triangular shape, which furnish a plentiful supply of oil. The tail stock is very rigid and heavy. The carriage is of a new design, being heavier and having larger bearing surfaces than generally used, adapting it for the heavy duty for which the lathe has been designed. The compound rest is also of a new design and is clamped by bolts on either side. Both the cross feed screw and the compound rest screw have micrometer collars. The friction knobs for throwing in and out the gears and the longitudinal feeds are made with a series of small beads on the circumference, thus allowing the operator to get a better grip on them. The rack pinion is so made that it may be withdrawn at any time when chasing threads.

The machine illustrated is equipped with a modification of the rapid change system generally used, and also with a rapid feed changing box, which furnishes six feeds in geometrical progression. If desired the lathe may be equipped with the well-known Ideal rapid change gears. Whichever arrangement is used an automatic stop and reverse is arranged for, it being possible to control the reverse from either the head or the apron. Tests have been made on 60 point carbon steel with a feed of 5/32 in., a reduction in diameter of 1½ in., and a cutting speed of 60 ft. per minute. One of these lathes was on exhibition at the Atlantic City conventions in June.

SUCCESS CHEMICAL FIRE EXTINGUISHER.

The H. W. Johns-Manville Company, 100 William street, New York, has recently brought out a new portable fire extinguisher. This extinguisher is unusually strong and heavy and is made of non-corrosive materials throughout. The body is of extra heavy cold rolled copper securely riveted and reinforced and is tested to a pressure of 350 lbs. or four times the required strength. The hose, which is tested to 400 lbs. to the square inch, is joined to the body by a swivel ground joint and cannot be pulled off, being detachable only by means of a wrench.

The extinguisher is put into action by simply being turned bottom side up and the resultant mixture of the sulphuric acid in the bottle secured in a brass cage on the interior, with the three gallons of water charged with bicarbonate of soda, develops instantly a pressure sufficient to send a chemical stream a distance of 50 ft. The flow of the sulphuric acid is automatically regulated so that the correct amount of gas is generated at all times and explosion is impossible. The chemical stream from this extinguisher acts as a blanket and smothers the fire; the acid, however, is all neutralized before it leaves the machine and the stream will not injure the material with which it comes in contact. This extinguisher is approved by the National Board of Fire Underwriters.

CONVENTION OF RAILROAD MASTER BLACKSMITHS' ASSOCIATION. —The sixteenth annual convention of the International Railroad Master Blacksmiths' Association will be held at the Grand Hotel, Cincinnati, O., August 18, 19 and 20. At this convention

papers on the following subjects will be presented: Flue Welding, George Lindsay, chairman; Tools and Formers for Bulldozers and Steam Hammers, H. M. Stewart, chairman; Case Hardening, W. V. Laizure, chairman; High Speed Steel and the Results Obtained, J. S. Sullivan, chairman; Piece Work, T. J. McCann, chairman; Frogs and Crossings, T. F. Keane, chairman; Locomotive Frame Making and Repairs, J. T. McSweeney, chairman, and Thermit Welding, G. W. Kelley, chairman. Mr. A. L. Woodworth, Lima, O., is secretary and treasurer of this association.

BOOK NOTES.

Locomotive Engine Running and Management. By Angus Sinclair. Twenty-second edition. Revised and enlarged. 430 pages. Cloth. Illustrated. Published by John Wiley & Sons, 43 E. 19th street, New York. Price, $2.00.

This book needs no description to the older enginemen and to the younger men it will suffice to say that its title conveys the best idea of the work and is accurate in every sense of the word. If more is needed it is given in the sub-title, which states that the book explains how to manage locomotives in running different kinds of trains with economy and dispatch; gives plain descriptions of valve gears, injectors, brakes, lubricators and other locomotive attachments; treats on the economical use of fuel and steam and presents valuable directions about the care, management and repairs of locomotives and their connections.

Locomotives a Vapeur. By Joseph Nadal. Bound in cloth; 4½ x 7 in.; 300 pages; illustrated. Published by the Encyclopedie Scientifique, 8 Place de L'Odéon, Paris, France. Price, $1.00.

This book deals in detail with the design and construction of modern French locomotives, being fully illustrated with examples of the latest and best practice in that country. It is written in French.

CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Inter-Pole Motors.—The Electro-Dynamic Co., Bayonne, N. J., is issuing circulars Nos. 32 and 33, both being on the subject of the inter-pole variable speed motors for driving machine tools, etc. These circulars contain some very interesting information.

The Foundrymen's Reference Book.—The Whiting Foundry Equipment Company, Harvey, Ill., is issuing a booklet which, in addition to many of its well known devices, also contains a few arrangements for reducing operating costs in foundries that are absolutely new. This company furnishes everything that is needed in the modern foundry.

Gisholt Methods in Railroad Shops.—The Gisholt Machine Company, Madison, Wis., is issuing a pamphlet describing and illustrating the Gisholt lathes as applied to railroad uses: also various Gisholt tools. These include illustrations showing the machine and the work which it is capable of doing. Most of the catalog is given up to the work within the capacity of the Gisholt lathe which was illustrated and described on page 24 of the June issue of this journal.

Railway Converter Sub-Stations.—The General Electric Company, Schenectady, N. Y., has just issued a very comprehensive bulletin (No. 4593), devoted to the above subject. This publication gives a general description of the various pieces of sub-station apparatus, including rotary converters, transformers, reactances, blowers, cables, switch-boards, etc., and includes illustrations of converter stations operated by various well-known railway companies. It contains also plans and elevations showing different arrangements of sub-station apparatus. Bulletin No. 4590, on the subject of self-starting devices for alternating current motors, is also being issued.

Lathes, Valve-Milling Machines and Oil Separators.—The American Tool and Machine Company, 109 Beach street, Boston, Mass., is issuing an illustrated catalog showing a number of new and very interesting designs of the above machines. The catalog is given up principally to turret lathes, which are shown in a variety of sizes and with a number of new attachments. Several machines for separating oil from chips, turnings or cuttings of any kind are also included.

Grinding Points Ground Down.—The Norton Co., Worcester, Mass., is issuing a little booklet which contains a large number of most valuable hints and helps for all those who have grinding to do. This covers very fully the subject of the selection of a wheel, the mounting and truing, the speed and general suggestions on grinding. These helps are the result of a long and very intimate experience of this company in this field and are of the greatest value.

Electric Generators.—Among the bulletins recently issued by the Crocker-Wheeler Company, Ampere, N. J., are No. 103 which fully illustrates and thoroughly describes the hydroelectric development on the Chicago Drainage Canal, which at present has a capacity of 16,000 h. p. and will ultimately deliver 36,000 h. p. Bulletin No. 104 describes the type of direct current railway generators now being built by this company and shows illustrations of a number of recent installations.

Mallet Articulated Compound Locomotives.—The Baldwin Locomotive Works, Philadelphia, Pa., is issuing Record No. 65, which consists largely of a very comprehensive and complete paper read by Mr. Greenough before the Engineers' Club of Philadelphia, March, 1908, on the Mallet Articulated Compound Locomotive. The Record also includes illustrations and complete dimensions of a number of designs of this type of locomotive which have been built by this company. Line drawings showing some of the more important details of several of these designs are also included.

Sweating Pipes.—Damage is often caused during hot weather by the collection of moisture on water pipes to an extent which causes it to drip and damage merchandise, carpets, etc. The H. W. Johns-Manville Company, 100 William street, New York, is issuing a leaflet describing its anti-sweat pipe covering, which is a sure preventive of this difficulty and is very reasonable in price. The same company is also issuing a leaflet descriptive of its compound called "Ferro-Cement," which is used for smoothing over and filling in blow holes in iron and steel castings.

Bolt and Pipe Threading, and Nut Tapping Machinery.—The Foote-Burt Company of Cleveland has issued a catalog describing the Reliance bolt threading, pipe threading and nut tapping machinery and accessories made by it. The catalog opens with a detailed description of the Reliance die head and its operation. Other details of the bolt cutters are then considered, after which specifications and illustrations are presented for the different sizes and types of these machines. The application of the motor drive is also considered. Information is presented concerning adjustable tap chucks, short hob or master taps and machine or nut taps. A short section describes the making and recutting of dies and this is followed by a number of reference tables, including information concerning standard screw threads; decimal equivalents of parts of an inch; millimeters in inches; table of surface speeds, including the speeds recommended for cutting bolts and tapping nuts; length of threads cut on bolts; English and Whitworth standard pipe threads; standard dimensions of wrought iron welded pipe; lap welded well casing and a table of areas, weights per lineal inch and weights per lineal foot of round bolt iron.

NOTES

Willis C. Squire.—Mr. Squire announces that he has opened an office as manufacturers agent at 209 Western Union Building, Chicago. He will handle railway supplies and specialties, gasoline locomotives, turntables, cranes, signaling devices, track materials, etc.

Crocker-Wheeler Company.—The following officers of the above company were elected on July 10th: President, S. S. Wheeler; Vice-President and Chief Engineer, Gano Dunn; Second Vice-President, A. L. Doremus; Secretary, Rodman Gilder; Treasurer, W. L. Brownell; Assistant Secretary, J. B. Milliken, and Assistant Treasurer, G. W. Bower.

Dearborn Drug and Chemical Works.—At a recent meeting of the Board of Directors of this company. W. A. Converse was elected to the position of secretary and chemical director, and Ralph Browning was elected to the office of treasurer. Both of these gentlemen have been connected with the company for several years.

Pressed Steel Car Company.—At the Atlantic City conventions the Pressed Steel Car Company exhibited one of the order of 85 steel passenger coaches which it is now delivering to the Pennsylvania Railroad. These cars are unusually interesting in design and attractive in appearance. They were fully illustrated and described on page 232 of the June, 1907, issue of this journal.

Sale of the Schoen Steel Wheel Plant.—The Carnegie Steel Co., Pittsburgh, Pa., has bought the property of the Schoen Steel Wheel Co., Philadelphia, Pa., whose plant is at McKees Rocks, Pa. Charles T. Schoen, who established the plant and was its sole owner, has retired from active work, but he will, however, continue with the steel corporation in an advisory capacity as regards the wheel plant. The transfer involves the plant at McKees Rocks, which has been running about three years and has a capacity of 800 wheels a day, some 21 acres of ground adjoining the plant of the Pressed Steel Car Co., of Pittsburgh, Pa., and a steel plant about half completed. Some time ago Mr. Schoen decided to erect a steel plant to furnish the steel needed in the wheel plant. Whether this will be completed or dismantled is not yet decided.

A PRACTICAL DRAWING OFFICE SYSTEM

CANADIAN PACIFIC RAILWAY.

BY G. I. EVANS, CHIEF DRAUGHTSMAN.

PART II.

SYNOPSIS.

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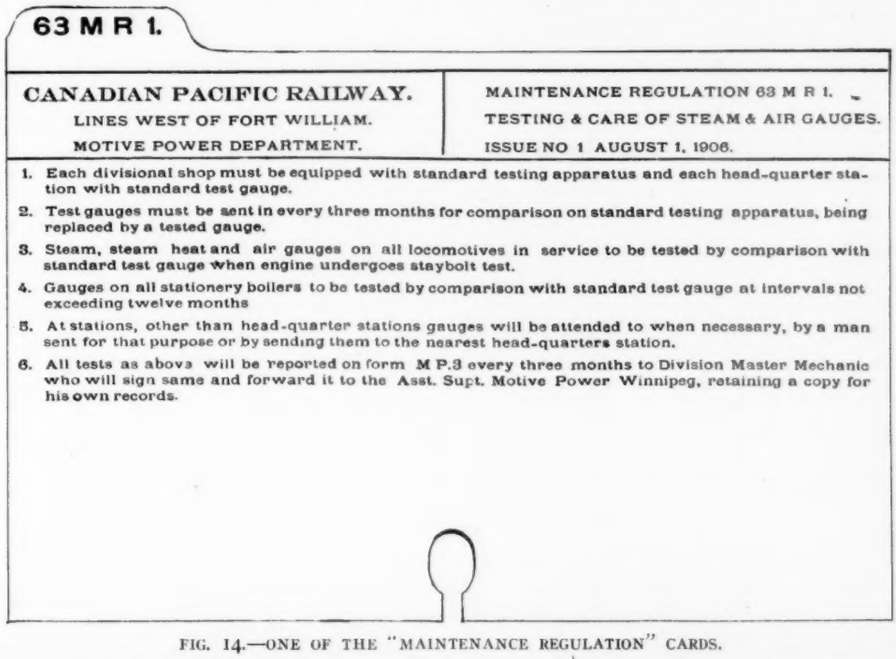
Maintenance Regulations.—Maintenance regulations describing the manner in which certain recurrent duties are to be performed, such as washing and testing boilers; testing staybolts, gauges, etc.; inspection of wheels; limits of wear of tires, axles, piston rods and a variety of subjects which are not convenient to issue by means of blue prints, are issued on what are known as "Maintenance Regulation Cards," samples of which are shown in Figs. 14 and 15.

These are printed by the 8 x 11 in. press on heavy 5 x 8 in. cards, the same group classification being used as for tracings. The designating letters have, however, been changed to "M. R.," which indicate a "Maintenance Regulation." The office record



63 M R 1.

CANADIAN PACIFIC RAILWAY.
LINES WEST OF FORT WILLIAM.
MOTIVE POWER DEPARTMENT.

MAINTENANCE REGULATION 63 M R 1.
TESTING & CARE OF STEAM & AIR GAUGES.
ISSUE NO 1 AUGUST 1, 1906.

1. Each divisional shop must be equipped with standard testing apparatus and each head-quarter station with standard test gauge.
2. Test gauges must be sent in every three months for comparison on standard testing apparatus, being replaced by a tested gauge.
3. Steam, steam heat and air gauges on all locomotives in service to be tested by comparison with standard test gauge when engine undergoes staybolt test.
4. Gauges on all stationery boilers to be tested by comparison with standard test gauge at intervals not exceeding twelve months
5. At stations, other than head-quarter stations gauges will be attended to when necessary, by a man sent for that purpose or by sending them to the nearest head-quarters station.
6. All tests as above will be reported on form M P.3 every three months to Division Master Mechanic who will sign same and forward it to the Asst. Supt. Motive Power Winnipeg, retaining a copy for his own records.

FIG. 14.—ONE OF THE "MAINTENANCE REGULATION" CARDS.

of these cards is kept by an index, similar to that used for tracings. Revisions or additions to any of the cards in use are made by a re-issue, all cards out on the road being called in, corrected and again sent out under a new issue number, which is printed on them together with the date of revision.

Maintenance regulations are issued to all motive power and other officials having charge of the work described on them, and, when kept in ordinary card file trays, arranged by group, form a very convenient reference.

Changes and Revisions.—It becomes necessary from time to time, to make certain changes in the details of equipment, either along the lines of improved appliances or strengthening parts which have proven weak. A great amount of this work can be very successfully handled at the various division shops and roundhouses, but to do so it is essential that some system be adopted of notifying the officials concerned and giving them full instructions as to how and when the work is to be done, also the reasons for so doing.

These conditions can be met best by issuing blue prints showing the changes to be made, accompanied by a manifest which will give all additional particulars as to the performance of the work. Such a system has been worked out by the revision notice column located on the card at the upper right-hand corner of every tracing (Fig. 7), used in conjunction with a manifest form as shown in Fig. 16.

The exact method employed is first to make the necessary changes to the tracing; a record covering the revision is entered in the column provided for that purpose, as shown in Fig. 7. The manifest is now numbered and written up, one being addressed to each person who receives a print of the revised tracing, the number and title of which is written in the columns headed respectively "Drawing Number" and "Subject"; in the "Remarks" column is a short description of the change and reason for it, so as to give the recipient a clear understanding of the work, while in the column headed "Application" the time at which it is to be done, such as "Immediately," "First shopping," etc., is filled in. On receipt of the manifest and prints the receipt form is signed and returned to the drawing office, where it is filed.

Distribution of Blue Prints, Etc.—These manifest forms may also be used for the issue of prints for record purposes, pattern catalog and manufactured material lists, etc. The issue symbols, previously mentioned in this article, are used for both the ordinary issue of prints to Angus Shops for new work, and manifest issues, such as have just been described, a space also being reserved on the manifest form for their insertion. These symbols are shown at the top of the following page.

The object of these issue symbols is this: When a new trac-

A Angus Shops ..... { 1 Print for Supt. of Shops.
1 " on sheet iron for Machine Shop.
B " " ..... 1 " " " " " Boiler Shop.
C " " ..... 1 " " " " " Blacksmith Shop.
D " " ..... 1 " " " " " Switch Shop.

G { 1 Print
1 " on sheet iron } Divisional Main Shops.
McAdam Junction.
Carleton Junction.
Toronto Junction.
North Bay.

R 1 Print for Main Roundhouse } McAdam Junction.
Vanceboro.
Brownville.
Megantic.
Farnham.
Montreal (Glen Yard).
Hochelaga.
Outremont.
Carleton Junction.
Chalk River.
Havelock.
Toronto (Union Station).
Toronto Junction.
London.
Windsor.
North Bay.
Cartier.
Chapleau.
White River.
Schreiber.
Webbwood.

S 1 Print on sheet iron for Main Roundhouse }

V—Drawing Office File,
X—New engine file,
Z—General file.

SYMBOLS USED IN CONNECTION WITH THE DISTRIBUTION OF BLUE PRINTS.

ing is made the shops or individuals requiring copies are determined upon, and the letter or letters representing these issues are entered in the proper column on the tracing; all persons having anything to do with the subsequent handling know exactly what prints are to be supplied and to whom they are to be delivered; itemizing, the procedure is as follows: In the case of a manifest issue the official dictating the manifest determines who shall receive copies and the stenographer writing it knows from the symbols mentioned, how many sheets to write and to whom to address them; the symbols, in the meantime are noted on the tracing which is sent to the printing office and the foreman there knows without further instruction how many prints to make and how many to mount on sheet iron.

Suppose that the above issue was to "G. R.," which indicates one reference print and one mounted on sheet iron for each division main shop and one reference print for each division roundhouse, all of which would, naturally, be sent to the official in charge of that division for distribution to his subordinates. He, having the dispatch symbols before him both on his manifest and print, will know at once for whom the other prints are intended.

In the case of a new tracing which is to be issued to Angus Shops on a locomotive building order, a manifest is of course unnecessary, full instructions being on the drawing. The issue symbols in this case, for a forged locomotive detail requiring machining, would be A, C, X, indicating one print for the shop superintendent's reference file, one each mounted on sheet iron for the machine and blacksmith shops and one to be bound in the drawing office record book for the locomotive represented. The tracing bearing these symbols is sent to the printing office, the proper number of prints is made and three of them are sent to the shop superintendent, his clerk knowing at once how to dispose of them without further instructions.

Such a system, in proper operation, works with mechanical precision, the progress of the prints from the time the tracing is approved being a series of predefined movements through the various departments, unnecessary handling and wrong delivery being eliminated by the simple addition of two or three letters on the tracing.

Changes in Progress.—One of the most serious and difficult problems which the average motive power drawing office is up against, is that of keeping the drawings and information lists which it has distributed through the various departments and shops, and which must still be regarded as part of the drawing office record, in a correct and up-to-date condition, so that they may be relied upon to tell accurately what is on any locomotive, car or other equipment. To illustrate this, suppose that a certain class of locomotive, of which there are fifteen, is to be rebuilt and a large number of the old parts replaced by new ones of an entirely new design. All these locomotives cannot be withdrawn from service immediately, and even if they could, no railroad shop has the facilities for doing all of the work at once. The work will extend over a period of from six months upwards and there will be two sets of records, one representing a gradually increasing number of locomotives of this class and the other a decreasing number. In the meantime both old and rebuilt locomotives will be in service, light repairs will be made on the old locomotives to keep them running until their turn comes to be rebuilt, the rebuilt locomotives will also be kept in repair, and new parts will be required from time to time for each.

Again, suppose a certain class of locomotive is to be equipped with a complete set of new side rods, which will take an entirely different design of bearing, and that orders have been issued to make the change only when the old rods show signs of failure; under these conditions it may be a matter of years before the last locomotive is changed, and in the meantime the bearings through natural wear will have to be renewed occasionally.

It will be evident from the two preceding examples that a railroad making use of a system of distributing information, such as the "Pattern" and "Manufactured Material" lists pre-

76 M R 1.

CANADIAN PACIFIC RAILWAY.
LINES EAST OF FORT WILLIAM.
MOTIVE POWER DEPARTMENT.

MAINTENANCE REGULATION 76 M R 1.
TYRE LIMIT OF WEAR AND THICKNESS.
ISSUE NO. 4 MARCH 2, 1907.

Tyre.	Type of locomotive.	Service.	Weight on pair of wheels.	Thickness at final turning.	MAXIMUM DEPTH OF GROOVE. After final turning	After other turnings
Driving.	All Types.	Pass.	30000 lb. or over	2 inches.	3-16 inch.	1-4 inch.
Driving.	All Types.	Pass.	Under 30000 lb.	1 3-4 inch.	3-16 inch.	1-4 inch.
Driving.	Mogul.	Freight	All weights.	1 5-8 inch.	1-4 inch.	1-4 inch.
Driving.	Consolidation.	Freight	All weights.	1 3-4 inch.	1-4 inch.	1-4 inch.
Driving.	10 Wheel.	Freight	All weights	1 5-8 inch.	1-4 inch.	5-16 inch.
Driving.	8 Wheel.	Freight	All weights.	1 1-2 inch.	1-4 inch.	5-16 inch.
Driving.	Switch.	Switch	30000 lb. or over	1 1-2 inch.	1-4 inch.	3-8 inch.
Driving.	Switch.	Switch	Under 30000 lb.	1 3-8 inch.	1-4 inch.	3-8 inch.
Eng. Truck	All Types.	All.	All weights.	1 3-8 inch.	1-8 inch.	3-16 inch.
Ten. Truck	All Types.	All.	All weights.	1 3-8 inch.	1-8 inch.	3-16 inch.

Engine and tender truck wheels must be taken out of service when tyres are less than 1 1-4 inch thick.

FIG. 15.—THE "MAINTENANCE REGULATION" CARD FOR THE LIMIT OF WEAR OF TIRES.

viously described, must also have a means of providing for just such contingencies. For this work a "Change in Progress" system has been adopted, consisting of three parts, as follows:

1. A means of keeping the official who has charge of the locomotives posted as to exactly what changes he is expected to make on each class, when they are to be made, and a reference to the prints which show these changes in detail.

2. A means by which the official who has charge of the work can report in a clear and concise manner, the time at which it is completed on each locomotive.

CANADIAN PACIFIC RAILWAY CO.

MOTIVE POWER DEPARTMENT.

Mr. ..... Montreal, *August 15th*, 1907.

..... Manifest No. *300*.

I furnish you herewith, Issue to *G. R.*

Drawing No.	Subject.	Remarks.	Application
51 L 134	*Combination lever for Walschaert Valve Gear, Class M4h.*	*Oil hole for radius bar pin and valve stem crosshead pin increased from ⅛" to ¼" dia.*	*Immediately.*

Kindly acknowledge receipt of these drawings and that same are thoroughly understood, on attached form; also arrange to destroy all previous copies of the above drawings as soon as existing requirements will allow.

CORRECT. APPROVED.

....

MECHANICAL ENGINEER. ASST. SUPT. MOTIVE POWER.

CANADIAN PACIFIC RAILWAY CO.

.....190

Asst. Supt. Motive Power.

The drawings shown on Manifest No. .....dated .....have been received, and instructions on Manifest are fully understood.

Signed. .....

FIG. 16.—FORM USED IN CONNECTION WITH CHANGES AND REVISIONS OF DRAWINGS.

3. A means by which the drawing office can keep a record of each engine changed, and on what date, until they have all been changed when the old record may be entirely superseded and a new permanent record made.

Full information as to the changes to be made is first issued to the shops or roundhouses which will do the work, by means of drawings showing the new part or parts to be applied or by a revision notice if the change is not of a complicated nature; in either case the blue prints thus supplied are issued on the manifest form shown in Fig. 16, accompanied by a sheet giving a list of all the changes which are to be made. This sheet is called a "List of Changes in Progress" and fulfils the conditions of the first part of the system, being issued for the purpose of keeping in an accessible, compact form a list of all changes which are to be made on different classes of locomotives.

The lists are printed on 8½ x 12 in. (size A) sheets, arranged to be bound in standard binders; one of these sheets is shown in Fig. 17, the first column headed "Item" being filled in with consecutive numbers which are used as a reference to the information contained on the different lines. The second column contains the sub-class or exact designation of the locomotives in question, while the third, fourth and sixth contain the title, number of the drawing and the date on which the revision or addition was issued; in the fifth column, headed "Application," is filled in the time at which the work is to be done, as "Immediately," "First Shopping," etc., conforming with the manifest.

Only one class of locomotive may be shown on a sheet, so that reference to the book in which these sheets are bound by classes shows the official in charge of the work exactly what is to be done to each. To insure these sheets being kept up to date, a new one is always sent out with each additional revision, the previous sheets issued being destroyed.

The second condition of the system, or means of reporting the changes made, is fulfilled by the form shown in Fig. 18, which is headed "Report of Changes in Progress." A supply of these forms is kept at each repair shop and as soon as any changes have been made to a locomotive a report blank is filled out, separate sheets being used for each. The first five columns are filled in exactly as on the "List of Changes in Progress," the item numbers corresponding, which gives a reference from one sheet to the other; the sixth column shows the date on which the work was completed. These sheets, being correctly filled in and sent to the drawing office, make it possible to keep an accurate record, engine by engine, as the work progresses, even though it should be scattered over a period of months.

The third condition of the system, or means by which an accurate record can be kept of each locomotive changed, is accomplished by the form shown in Fig. 19, which is called "Record of Changes in Progress." These sheets are also bound, arranged by classes, in 8½ x 12 in. binders, each showing only locomotives of one class, the numbers of which are filled in consecutively under the heading "Locomotive No." The slanted extensions to the vertical columns are filled in with the item numbers and names of the changes applying to the class of locomotive shown on the sheet, the item numbers corresponding to those on the "List of Changes" which was sent out with the manifest and instructions for doing the work.

On receipt of a report form showing that certain changes have been made to a locomotive, the proper column is located on the record sheet by means of the item number and name of the revision; the date on which the change was made as taken from the report sheet is then entered in it opposite the locomotive number and as soon as all the locomotives of that class are shown as being changed the record for that particular item is complete, the old drawings may be superseded and the new ones marked up for the complete class. Reference to the notations on the sheets, Figs. 17, 18 and 19, shows very clearly how the work is followed up.

CAN. PAC. RY.

LIST OF CHANGES IN PROGRESS CLASS *M4*

ITEM NO.	SUB CLASS	TITLE	DRAWING NO.	APPLICATION	DATE ISSUED
1	M4a-h	Equalizer Hanger	69L 20	Renewals	Feb. 21st 1905
2	M4a-h	Eccentric Rod	33L 8	Immediatly	Dec. 14th 1905
3	M4a-h	Front Cylinder Head Safety Groove	28L 2	1st Shopping & Renewals	May 23rd 1906
4	M4h	Combinaion Lever	51L 134	Immediatly	Aug. 15th 1907

FIG. 17.—FORM SHOWING LIST OF CHANGES IN PROGRESS.

CAN. PAC. RY.

REPORT OF CHANGES IN PROGRESS

LOCO. NO. *1665* CLASS *M4*

ITEM NO.	SUB CLASS	TITLE	DRAWING NO.	APPLICATION	DATE CHANGED
4	M4h	Combinaion Lever	51L 134	Immediatly	Aug. 29th 1907

FIG. 18.—REPORT FORM FOR CHANGES IN PROGRESS.

Receipts for Prints.—A special form of receipt used for miscellaneous print or other issues is shown in Fig. 20. These are used as a reply to a request for prints, etc., and when returned properly signed, form a record that the prints asked for were received by the person addressed.

These receipts are printed in books containing one hundred blank forms with plain sheets underneath, to which any notations made on the top sheet are transmitted by carbon paper; the top sheets are perforated and may be detached to send out with the prints, the duplicate which remains in the book serving as the

O

CAN. PAC. RY.

LOCOMOTIVES 1661-70 RECORD OF CHANGES IN PROGRESS

CLASS M4h

LOCO NO	Item 1 (Equalizer Hanger Drawing No. 69L20)	Item 2 (Eccentric Rod Drawing No. 33L8)	Item 3 (Front Cylinder Head Safety Groove Drg. No. 28L72)	Item 4 (Combination Lever Drawing No. 57L134)			
1661	Mch. 1,05	Dec. 20,05	Jun. 29,06	Sep. 29,07			
1662	Apl. 10,05	Dec. 26,05	Oct. 20,06	Oct. 15,07			
1663	Jun. 16,05	Jan. 5,06		Nov. 1,07			
1664	Jun. 7,05	Dec. 29,05					
1665	Apl. 18,05	Apl. 13,06	Aug. 5,06	Aug. 29,07			
1666	Jun. 20,05	Mch. 5,06	Sep. 15,06				
1667	Nov. 1,05	Jan. 3,06		Aug. 25,07			
1668	Sep. 8,05	Dec. 26,05	Dec. 7,06	Sep. 1,07			
1669	Apl. 5,05	Mch. 1,06					
1670	Aug. 16,05	Jan. 15,06	Jan. 6,07	Oct. 5,07			

FIG. 19.—FORM FOR KEEPING RECORD OF CHANGES IN PROGRESS.

record showing that the request has been attended to. The originals when properly receipted and returned are indexed and filed, so as to be readily located, if necessary to prove that certain prints were issued.

Material Lists for New Equipment.—As a large part of the locomotives and other equipment required by the Canadian Pacific Railway is built at its own shops, all of it being to the company's design, a short description of the material and drawing record lists may be of interest. For each order of locomotives built, it is necessary to place requisitions on the purchasing department which will show exactly what material is required and how much, with full particulars as to size, quality, etc.

As the material required to build a locomotive may be divided into three main groups, each containing approximately the same number of items, namely, gray iron castings, brass castings and general material, three books may very conveniently be used, one each for gray iron castings and brass castings, sample sheets of which are shown in Figs. 21 and 22, respectively, and one for general material, as shown by Fig. 23, which contains a record of all the other material used, such as tires, boiler and tank plates, steel and malleable castings, etc.

It is preferable that these books be arranged to show the material required for one locomotive, as in the case of duplicate orders it is only necessary to multiply by the number of locomotives in the order, when making out the requisitions. Reference to the sample sheets, Figs. 21 and 22, show that spaces are provided for the date of entry which is also the date on which the order is placed, the name and pattern number of the casting, number of the drawing on which it is shown, and its weight which is useful both for comparison and for checking the amount of material contained in the order. The list also shows the dates on which the foundry will have to deliver the first and last castings in order to keep up with the schedule arranged for the completion of the locomotives; of the three remaining columns that headed "Item" which is filled in with consecutive numbers is used for convenience in referring to the casting shown in that particular line. "Check" is used for the checkers initials and "Remarks" for any miscellaneous information, such as the location of pattern, revision notes, etc.

The record in the general material list, shown in Fig. 23, is very complete and contains full particulars as to the size, quantity, material, etc., of the parts on order, spaces being provided for "Item," quantity required for one locomotive and date of entry, all of which are filled in similarly to the casting list.

The column headed "Description of Material" is outlined in such a manner as to necessitate only the addition of a few figures, etc., to complete a full description of the part required. That headed "Delivery Asked" is filled in with the date on which it will be necessary to have the material at the shops to keep up with the building schedule, while the two remaining columns "Ordered From" and "Stores Order Number," are filled in with the name of the firm on which the order has been placed and the number of the stores department order.

These lists are arranged by the elevation draughtsman in charge of the design, entries being made by him as the work progresses and when sufficient information has been worked up the books are turned over to the requisition clerk who makes out the orders.

The books are also convenient as an office record containing, as they do, particulars of every part entering into the construction of each locomotive. They may also be issued to the shops for guidance during the performance of the work. "Drawing Record Lists," as shown by Fig. 24, are made to show the numbers and titles of all drawings used on the locomotives to be built. They also show the date on which the prints were issued to the shops and other information of a similar nature.

This general description covers the principal parts of the drawing office system used in the motive power department of the Canadian Pacific Railway, which was worked out under the direct supervision of H. H. Vaughan, assistant to the vice-president, by L. R. Johnson, assistant superintendent of motive power, and A. W. Horsey, mechanical engineer.

The system has been in operation several years with uniformly satisfactory results, practically no changes having been found necessary in the original scheme.

CANADIAN PACIFIC RAILWAY CO.

OFFICE MECHANICAL ENGINEER

MONTREAL ..... 190 .

No. . . .

Mr. . . .

Dear Sir:—

Complying with your . . . . .

. . . . . .

. . . . . .

I send you herewith drawings mentioned below for which kindly sign and return this sheet.

Yours truly,

A. W. HORSEY,

Mechl. Engr.

DRAWING No.	TITLE

Received the above drawings to-day in good order.

. . . . . .

DATE . . . . . .

FIG. 20.—FORM OF RECEIPT FOR MISCELLANEOUS BLUE PRINTS.

CANADIAN PACIFIC RAILWAY
MOTIVE POWER DEPT.
IRON CASTINGS

CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____

ITEM	CHECK	DATE OF ENTRY	PIECES PER ENGINE	NAME OF CASTING	PATTERN NO.	DRAWING NO.	WEIGHT OF ONE PIECE	FIRST CASTING TO BE DELIVERED	LAST CASTING TO BE DELIVERED	REMARKS
1				Eng. Truck Center Casting	34L	34L				
2				" " " Pin	34L	34L				
3				" " " Washer	34L	34L				
4				" " " Plate	34L	34L				
5				" " " Pedestal	34L	34L				
6					34L	34L				

FIG. 21.—MATERIAL LIST FOR NEW EQUIPMENT—IRON CASTINGS.

CANADIAN PACIFIC RAILWAY
MOTIVE POWER DEPT.
BRASS CASTINGS

CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____

ITEM	CHECK	DATE OF ENTRY	PIECES PER ENGINE	NAME OF CASTING	PATTERN NO.	DRAWING NO.	WEIGHT OF ONE PIECE	FIRST CASTING TO BE DELIVERED	LAST CASTING TO BE DELIVERED	REMARKS
1				Try Cock Valve	24L	24L				
2				" " " Bodies	24L	24L				
3				" " " Stem bonnet	24L	24L				
4				" " " Dripper	24L	24L				
5				" " " Extension	24L	24L				
6					24L	24L				

FIG. 22.—MATERIAL LIST FOR NEW EQUIPMENT—BRASS CASTINGS.

CANADIAN PACIFIC RAILWAY
MOTIVE POWER DEPT.
GENERAL MATERIAL

CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____

ITEM	CHECK	NO. OF PIECES FOR ONE ENG.	DESCRIPTION OF MATERIAL	DATE OF ENTRY	DELIVERY ASKED	STORES ORDER NO.	ORDERED FROM
1			Brake-Driver Style Drivers dia.				
2			Elevation Drg. No. Weight on Drivers lbs.				
3			" " Trailers lbs.				
4			Shoes on of wheels				
5			Special Equipment				
6							

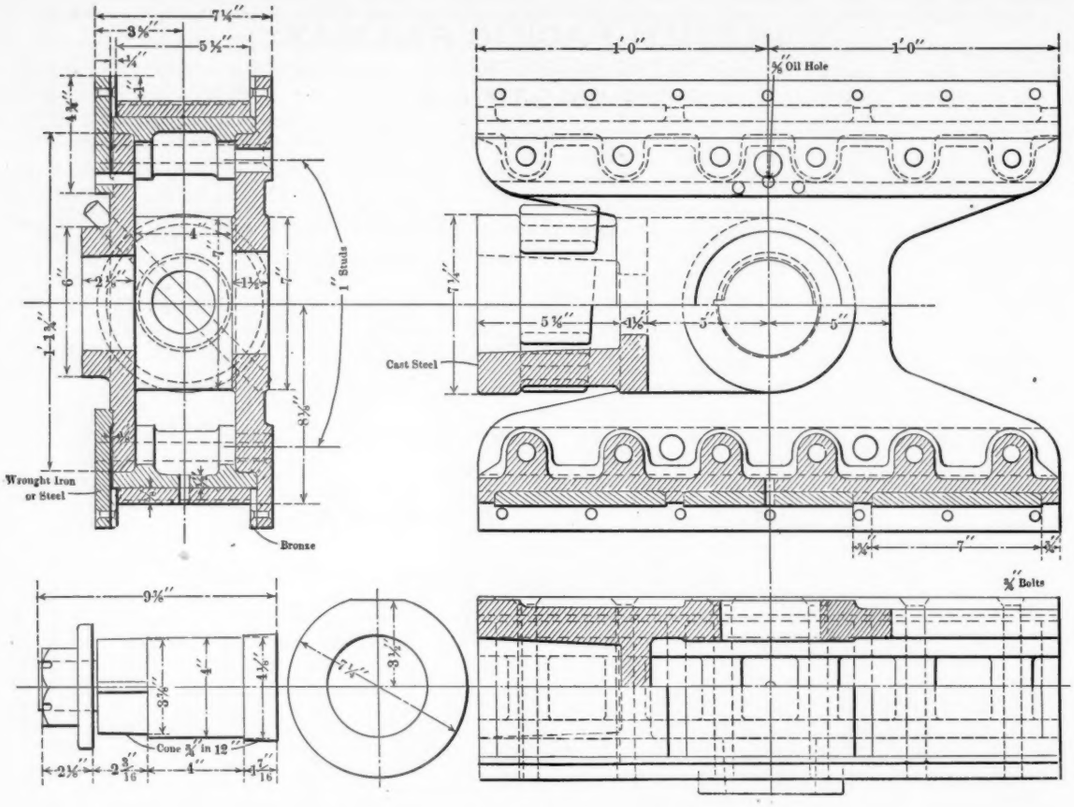
FIG. 23.—MATERIAL LIST FOR NEW EQUIPMENT—GENERAL MATERIAL.

CANADIAN PACIFIC RAILWAY
MOTIVE POWER DEPT.
DRAWING RECORD

CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____
CLASS_____ROAD NOS._____APPROPIATION NO._____BUILT_____19_____

ITEM	CHECK	NAME OF DRAWING	DRAWING NO.	ISSUE TO SHOP		REMARKS	ITEM	CHECK	NAME OF DRAWING	DRAWING NO.	ISSUE TO SHOP		REMARKS
				NO. OF PRINTS	DATE						NO. OF PRINTS	DATE	
1		Ash Pan	11L				61		Eng. Truck Box Brass	18L			
2		" " Air Hopper	11L				62		" " " Cellar	18L			
3		" " Axle guard	11L				63		" " " Liner	18L			
4		" "Butterfly Damper	11L				64		Trailing Truck Box	18L			
5		" " Cleaning Door	11L				65		" " "Brass	18L			
6		" " " Details	11L				66		" " " Dust guard	18L			

FIG. 24.—DRAWING RECORD LIST FOR NEW EQUIPMENT.



ALLIGATOR CROSSHEAD—CANADIAN PACIFIC RAILWAY.

IMPROVED FORM OF ALLIGATOR CROSSHEAD.

CANADIAN PACIFIC RAILWAY.

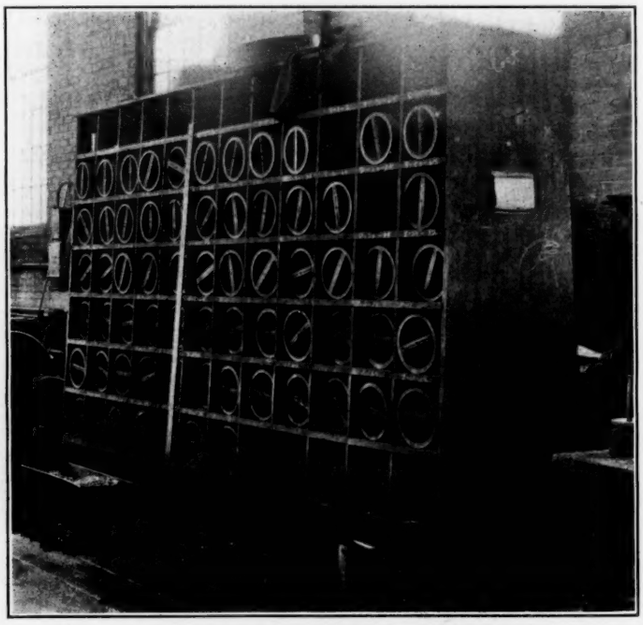
The alligator crosshead, shown in the drawing, has been experimented with on the Canadian Pacific Railway with very satisfactory results. The most important advantage is that the bearing strips or gibs, which may be made in one or more pieces (three shown on the drawing) can be lined up, or removed and replaced, at a comparatively small expense, it being unnecessary to disconnect the crosshead from the piston rod. All that has to be done is to slack off the nuts on the through bolts and remove the side plates. The slippers are of cast steel and divided by cross webs forming end checks for the gibs; the intermediate webs are removed when the gibs are made in one piece. The side plates when bolted up form a clamp to hold the gibs in place.

DRIVING BOX WORK AT THE GREAT NORTHERN RAILWAY SHOPS.

The driving box work at the Great Northern Railway shops in St. Paul is handled quite differently from the methods ordinarily in use at other shops. The boxes are first counter bored and babbitted on the hub side, after which the brass is pressed in by an air press; three brass pins are put in on the hub side, projecting a distance equal to the required thickness of the babbitt, and the box is filled with babbitt to this height, after which it is faced and bored on a 40-in. vertical boring mill.

The shoe and wedge faces are milled on a horizontal milling machine, no attention being paid to keeping these faces an equal distance from the center of the brass. In this way an unnecessary waste of material is prevented. In place of the ordinary inconvenient and laborious method of fitting each box to the journal upon which it is to be used, a set of mandrels has been provided, as shown in the illustration. These mandrels are hollow cast iron cylinders with a cross or center piece at each end so that they may be easily handled by the operator. The mandrels vary in size by 1/64 in. in diameter. All driving journals which are out of true 1/64 in. or more are re-turned. With these mandrels one man does all of the driving box fitting for the shop, and when the boxes leave his hands they are ready to be applied to the journals.

This operator, with the aid of a combination T square, which has a sliding attachment for locating the center of the brass, quickly and accurately locates the lines for the shoe and wedge faces and the center of the brass. From this the shoe and wedge gang, composed of two machinists and helpers, take the dimensions and lay out the shoes and wedges for the entire shop.



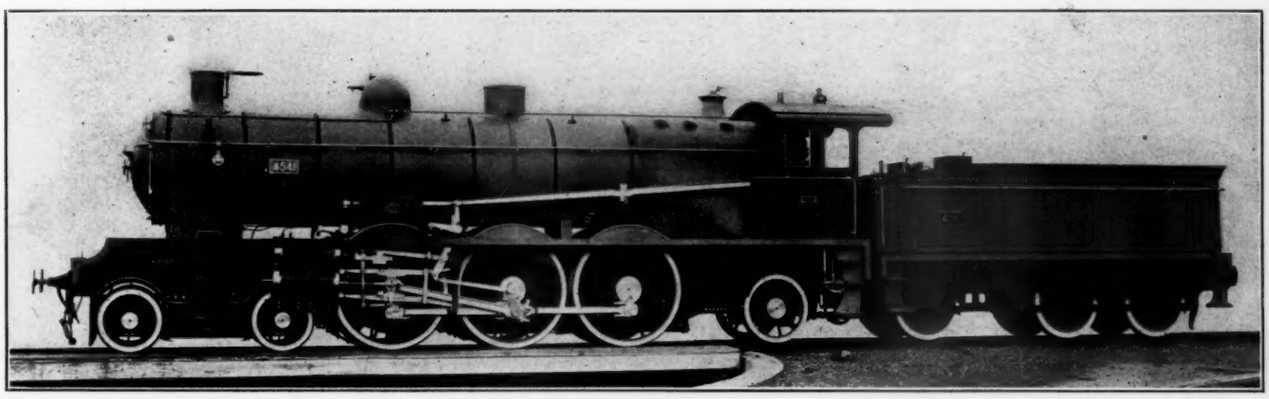
MANDRELS FOR DRIVING BOX WORK AS USED AT THE ST. PAUL SHOPS, GT. NORTHERN RAILWAY.

DE GLEHN COMPOUND PACIFIC TYPE LOCOMOTIVE

PARIS-ORLEANS RAILWAY.

The Schenectady Works of the American Locomotive Company are completing an order of thirty Pacific type locomotives for the Paris-Orleans Railway of France, in which, from the standpoint of American practice, a number of novelties in design are introduced. The locomotives were built from designs and specifications furnished by the railway and are duplicates of some engines already in service and others being built by other companies. The drawings were dimensioned in the metric system and were not transposed on the shop drawings at Schenectady. The workmen found no difficulty in working with the metric system.

These engines will be used in fast express service on the division between Limoges and Brive, a distance of 61.27 miles, where the grades are long and heavy in both directions. Coming from Brive there is, with the exception of a few short level stretches, an almost continuous up grade, averaging about ¾ per cent. for a distance of 29.5 miles, while coming in the other direction, the road from Limoges to the summit of the rise is more undulating and the grades steeper, but shorter, the steepest grade being about .95 per cent. and 7.14 miles long. The fastest trains weigh from 330 to 360 English tons behind the tender, and make



DE GLEHN COMPOUND PACIFIC TYPE LOCOMOTIVE FOR THE PARIS-ORLEANS RAILWAY.

the run between Limoges and Brive in one hour and 29 minutes, including 16 stops, while from Brive to Limoges, with the same weight of train, the time is 8 minutes longer. To meet these requirements a powerful engine with a large boiler capacity for high speed is needed, and the engines here illustrated are designed to haul trains of 440 tons on a 1 per cent. grade at a speed of 30 miles per hour.

The point of greatest novelty in the design is found in the firebox which, because of the desire to get a deep throat and avoid an excessive length of flue with three pairs of drivers driven by the De Glehn arrangement of balanced compound cylinders, is a combination of narrow type, between the frames, and the common wide type. It is 47.5 in. wide in front and 82.5 in. wide at the back end. In this way a grate area of 45.7 sq. ft. has been obtained in a firebox but 112 in. long inside. The manner of shaping the mud ring and flanging the side sheets to obtain this form is clearly shown in the illustrations.

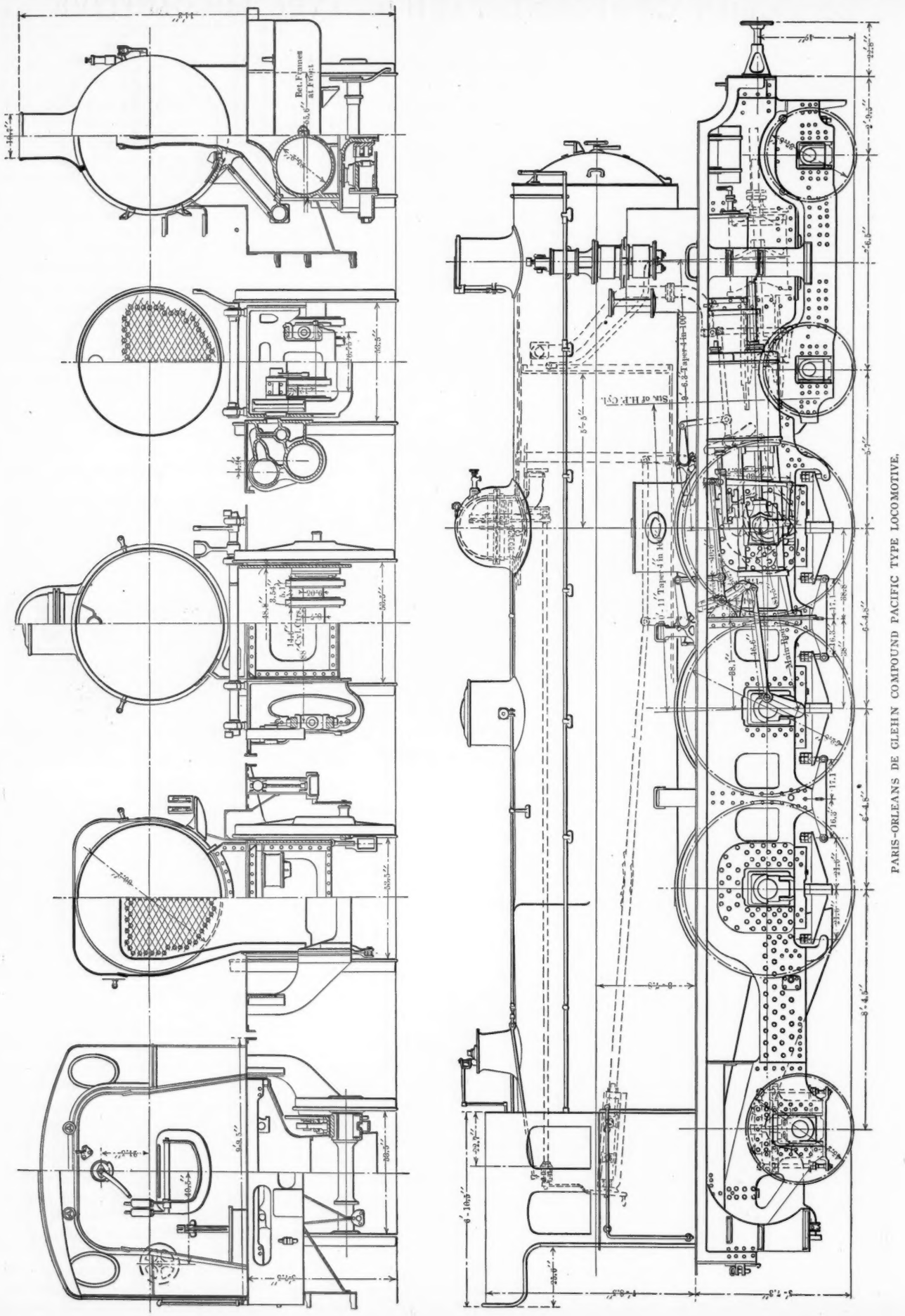
The De Glehn type of balanced compound locomotive is the common one in use for passenger service in France and has been tried in England and this country. It will be remembered that in 1904 the Pennsylvania Railroad purchased an Atlantic type locomotive of this design which was tested at the locomotive testing plant at St. Louis and has since been in regular service. This engine is reported to be very successful up to the limit of its capacity when handled by men who understand its operation. In brief the design comprises a four-cylinder compound in which the two high-pressure cylinders are outside the frames and located some distance back of the low-pressure cylinders, which are between the frames and directly below the smoke box. The high-pressure cylinders drive the second pair of drivers and the low-pressure the forward pair, which has a cranked axle. Each cylinder has an independent valve gear and the relations of the point of cut-off in the high and low-pressure pairs can be varied at the will of the engineer.

The steam pipes to the high-pressure cylinders are seamless drawn steel tubes, their connection to the cylinders being shown in the side elevation. Steam from the high-pressure cylinder exhausts into intercepting valves, located in chambers cast on the side of each low-pressure cylinder, directly beneath the steam chests. These valves are in the form of hollow cylinders forming a recess and have suitable openings cut in them, which, according to the position of the valve, allow the high-pressure exhaust to pass to the low-pressure steam chests and receiver, or to the atmosphere, through a direct exhaust passage cored out in the front of the low-pressure cylinder castings. These valves are operated by air pressure, controlled from the cab, the air cylinder being located between the frames just ahead of the low-pressure cylinders, and the ends of the piston rod being connected to crank arms on the ends of the intercepting valve stems.

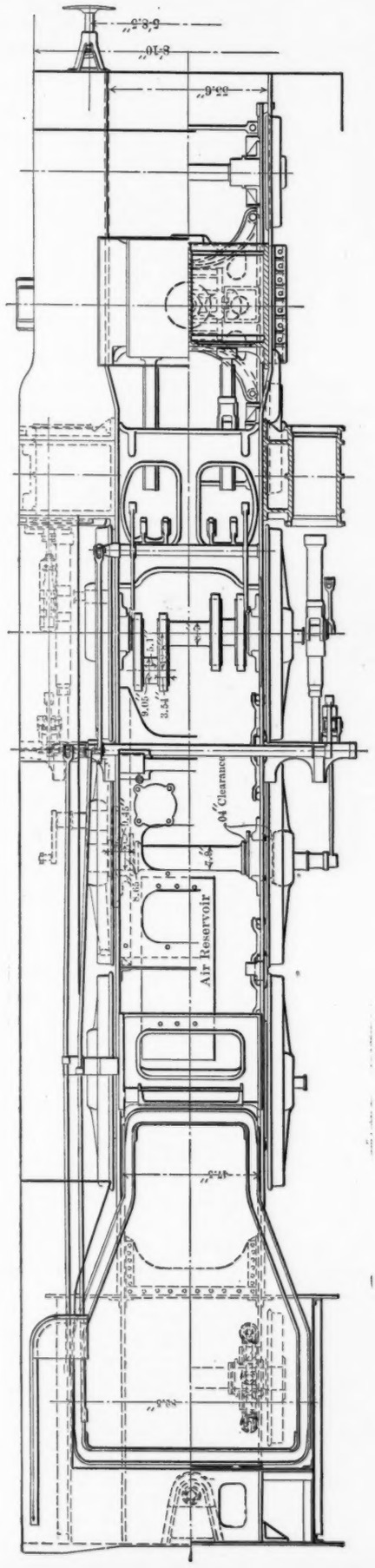
Steam direct from the dome is admitted to the low-pressure steam chests and receiver in starting or when working simple, by means of a valve located on the back-head of the boiler, which, when opened, allows steam to flow through a small copper pipe, extending from it through the front tube sheet and connecting to the copper pipe, shown in the side elevation, which connects to an opening in the receiver on the right side of the exhaust pipe. Another copper pipe connected to a similar opening in the receiver on the left side of the exhaust pipe extends out through the side of the smoke box and is provided with a relief valve which regulates the pressure of steam in the receiver. By this arrangement of connections and valves it is possible to operate either the high or low-pressure cylinders alone, either independently or in conjunction with each other.

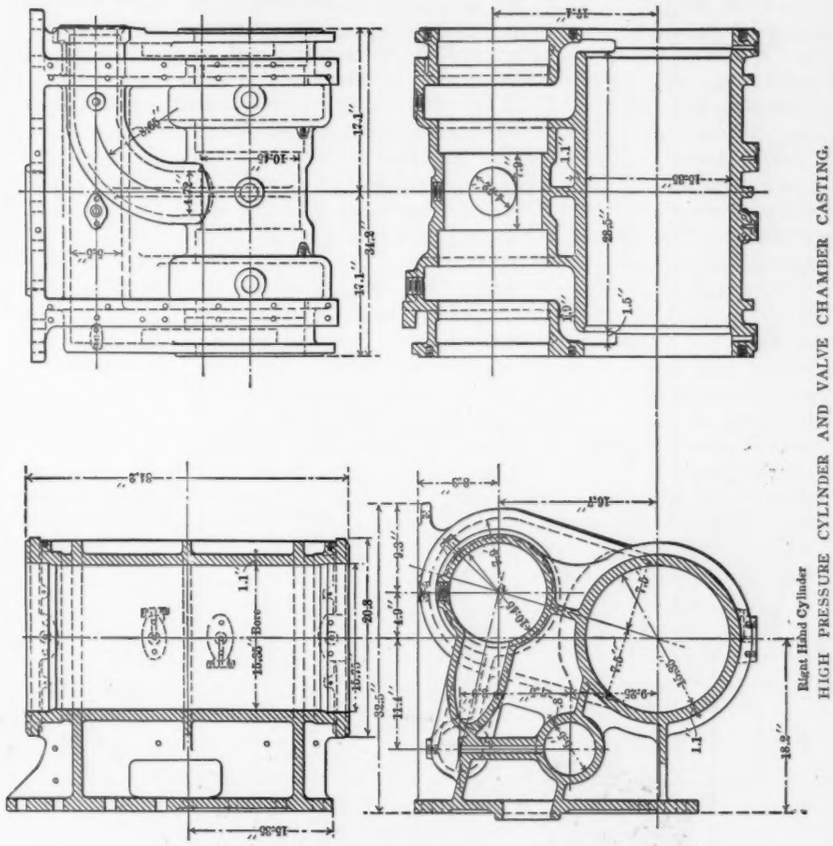
Most of the previous examples of the De Glehn compound have the steam pipes passing down outside the boiler shell directly to the high-pressure cylinders. In this case, however, the steam pipes are in their usual location in the front end and are continued by a short outside pipe to the front of the high-pressure cylinders.

Walschaert valve gear is used on both cylinders; the outside gear being operated by a return crank on the second pair of drivers and the inside by eccentrics on the cranked axle. The two reach rods are on the left side, located one behind the other. A screw reverse gear, which is arranged to permit the independent operation of the two sets of valve gear or to operate them together at a set ratio of cut-offs as desired, is placed on the left side in front of the engineer's seat. The throttle lever, which

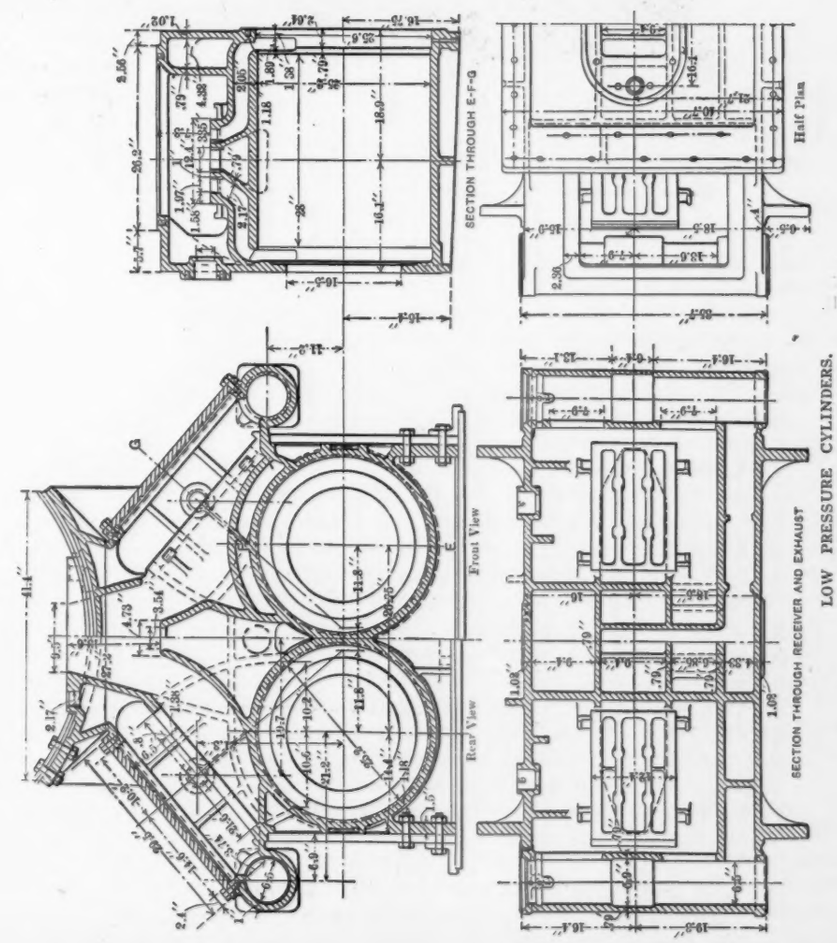


PARIS-ORLEANS DE GLEHN COMPOUND PACIFIC TYPE LOCOMOTIVE.





HIGH PRESSURE CYLINDER AND VALVE CHAMBER CASTING.



LOW PRESSURE CYLINDERS.

operates in a vertical plane instead of horizontally, as is universal American practice, is placed on the back head, the rod from the valve being inside the boiler and passing through a stuffing box at this point. In connection with the valve gear it will be noticed that the valve chambers of the high-pressure cylinders are set outside the cylinders so as to give a direct drive from the return crank, while with the inside gears there is a difference of nearly 14 inches between the plane of the valve stem and that of the eccentric. This offset is provided by means of an extended trunnion on the link with a downwardly extending arm at the end. To prevent any springing at this point the links have liberal supports at three points.

The details of the cylinder castings are shown in one of the illustrations. The high-pressure cylinders with the piston valve chambers are in separate castings, which are bolted to the plate frames just ahead of the front driving wheels. The steam passage continued from the front by a bend of large radius to the center of the valve chamber, and the exhaust passages, which are, of course, separated from entering steam by air spaces, emerge just below it and are continued to the receiver by a short section of heavily lagged piping. The castings are made as light as possible and of the best grade of grey iron. All passages are made individual as far as possible and stayed by ribs to each other and the main casting.

The two low-pressure cylinders, together with the saddle and their steam chests and receiver are in one casting. They set between the frames which are widened at this point to permit the use of 25.2 in. diameter cylinders. The low-pressure valves are of bronze and of the plain unbalanced slide type. They have inclined seats and extend slightly over the top of the frames. The passages throughout are very large and give free movement to the steam. In order to provide clearance for the front truck, all the cylinders are slightly inclined.

The boiler is also shown in detail in one of the illustrations. It is of the straight top type with Belpaire firebox, the firebox being copper. All the stays in the water legs are of manganese bronze, while the crown and boiler stays are of Falls Hollow stay bolt iron. The barrel is made up of sheets about .79 in. in thickness, there being three rings. The front tube sheet, which is nearly 1 in. thick, is flanged and set into the front course sheet. It is braced above the flues by two horizontal plates about 14 in. wide and .63 in. thick.

The dome construction is somewhat unusual and consists of a lower section of .6 in. steel flanged to fit the boiler, and a hemispherical upper section of the same material. The two are joined by a flange, the arrangement being such that the upper sheet fits inside the flange on the lower section in the manner shown in the illustration. The dome is set 65 in. back of the tube sheet.

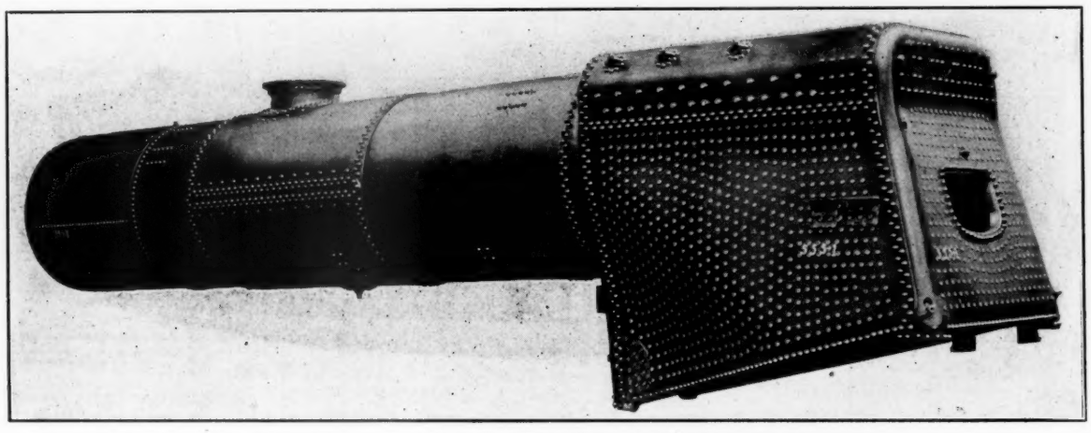
The boiler contains 261 tubes 2.165 in. in diameter, which are set at 2.84 in. centers. They have a drop of about two inches toward the firebox. The back tube sheet of copper is 1.18 in. thick where the tubes enter and is narrowed to .63 in. thick at the throat, where it is held by stays. The throat is 37.9 in. deep and the water space is 3.74 in. at the mud ring. The crown sheet has a slope of about 2 in. toward the rear and is made of copper .63 in. thick. It will be noted that the back head braces are all fitted with nuts for correct distribution of the stresses after the boiler is erected.

The grate has a very decided slope, the difference in level being 21.7 in. The door opening is of peculiar shape, shown in the illustration. It is 27.5 in. wide and 15.75 in. high. The back firebox sheet is dished at the door to permit the use of a door ring only 2.36 in. wide.

The method of setting the tubes is also shown in the illustration. The hole in the back sheet is taper and the tube is swaged down to enter and is rolled and beaded. The holes in the front sheet are straight, 2.24 in. in diameter and the tube is simply expanded and rolled.

The smoke-box is provided with a high exhaust pipe fitted with a variable exhaust nozzle. This device consists of a hollow cone fitted in the top of the exhaust pipe, the largest outside diameter of which is equal to the inside diameter of the tip of the nozzle. This cone is connected to the horizontal arm of a shaft which extends out of the side of the smoke-box, and is operated from the cab by means of a screw and hand wheel. By lowering or raising the cone, the amount of the exhaust opening is increased or diminished.

The blower nozzle, of bronze, is a hollow ring surrounding the exhaust nozzle and provided with a number of holes in its upper face. A sprinkling device is also provided in the smoke-box for extinguishing hot cinders. The smoke-stack is of cast iron, and is provided with a hood, by means of which the draft may be checked when the engine is standing in a station or drifting.

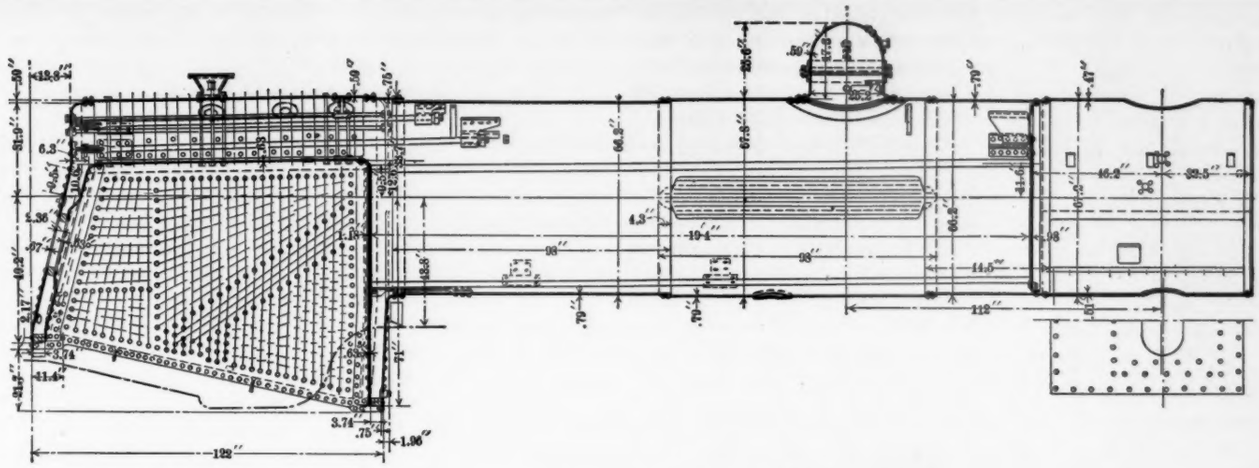


BOILER FOR THE DE GLEHN COMPOUND PACIFIC TYPE LOCOMOTIVE.

The frames are of steel plate in two sections, the main frames being 1.26 in. thick, and the rear section for the trailing truck being 1.18 in. thick. A good depth of plate is provided over the pedestals. They are very strongly tied together, the location and arrangement of the bracing being shown in the elevation and cross sections. The low-pressure guides and also the low-pressure link supports are bolted to the heavy steel box casting between the high-pressure cylinders. The outside guides and high-pressure link supports are bolted to cast steel guide yokes secured to the frames. All the axles are forged steel, the crank axle being a single forging. The driving boxes are also of forged steel.

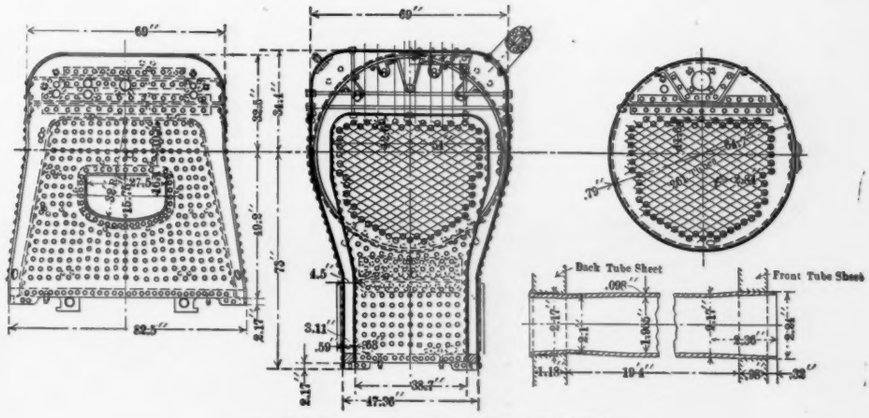
The three pairs of driving wheels are equalized together, the under-hung spring system being employed. Contrary to American practice in this type of engine, however, the trailing truck is not equalized with the driving wheels. It is of the side motion type with inside bearings, lateral motion being provided by 3.55 in. play between the boxes and pedestals on each side, and the load on the truck is utilized to bring it back to its central position.

The front engine truck is the Paris-Orleans standard design, all the weight being transferred to it by means of two hemispherical side bearings seated in castings which can slide on the



cast steel center frame. The truck is brought back to its central position after leaving a curve by means of two transverse coil springs, one on either side of the center plate.

The tender tank is of the water bottom type and has a water capacity of 5,300 gallons. It is provided with three gauge cocks on the left side to show the level of the water in the tank. The tender frame consists of two steel plate side frames, placed outside of the wheels and strongly braced together. The tender is carried on six wheels and the weight is transmitted to the journal boxes through semi-elliptic springs over the top of each box, the two rear pairs of wheels being equalized together.



BOILER—DE GLEHN COMPOUND LOCOMOTIVE.

The general dimensions, weights and ratios are as follows:

GENERAL DATA.

Gauge	4 ft. 9 in.
Service	Passenger
Fuel	Coal
Tractive effort	24,940 lbs.
Weight in working order	195,000 lbs.
Weight on drivers	122,000 lbs.
Weight of engine and tender in working order	294,800 lbs.
Wheel base, driving	12 ft. 9.54 in.
Wheel base, total	34 ft. 5.4 in.
Wheel base, engine and tender	58 ft. 5.2 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.9
Total weight ÷ tractive effort	7.8
Tractive effort × diam. drivers ÷ heating surface	597.0
Total heating surface ÷ grate area	66.5
Firebox heating surface ÷ total heating surface, per cent.	6.1
Weight on drivers ÷ total heating surface	40.2
Total weight ÷ total heating surface	61.1
Volume equiv. simple cylinders, cu. ft.	8.0
Total heating surface ÷ vol. cylinders	380.0
Grate area ÷ vol. cylinders	5.7

CYLINDERS.

Kind	DeGlehn Comp.
Diameter and stroke	15.35 and 25.2 × 25.6 in.

VALVES.

Kind	H. P.-Piston, L. P.-Slide
Greatest travel	H. P.-5.25 in., L. P.-5.7 in.
Outside lap	H. P.-1.06, L. P.-1.06 in.
Inside lap	H. P.-.118, L. P.-.197 in.

WHEELS.

Driving, diameter over tires	72.8 in.
Driving journals, diameter and length	8.65 × 9.45 in.
Engine truck wheels, diameter	37.8 in.
Engine truck, journals	5.9 × 9.85 in.
Trailing truck wheels, diameter	45.2 in.
Trailing truck, journals	7.1 × 11.8 in.

BOILER.

Style	Belpaire
Working pressure	227.6 lbs.
Outside diameter of first ring	66.2 in.
Firebox, length	112 in.
Firebox, width	F.-38.8, B.-74 in.
Firebox plates, thickness	.63 in.
Firebox, water space	F.-3.74, S.-3.1, B.-3.66 in.
Tubes, number and outside diameter	261—2.17 in.
Tubes, length	19 ft. 6 in.
Heating surface, tubes	2,863.5 sq. ft.
Heating surface, firebox	184.7 sq. ft.
Heating surface, total	3,048.2 sq. ft.
Grate area	45.7 sq. ft.
Smokestack, diameter	19.7 in.
Smokestack, height above rail	171 in.
Center of boiler above rail	111 in.

TENDER.

Tank	Water Bottom
Frame	Steel
Wheels, diameter	48.8 in.
Journals, diameter and length	5.5 × 9.85 in.
Water capacity	5,300 gals.

LONGITUDINAL VS. TRANSVERSE SHOPS.

After a thorough experience with both types, I have come to prefer the longitudinal shop for any location where the surroundings will permit its use. My principal reasons for this preference are as follows:

(1) The transverse requires between twenty-five and thirty per cent. more erecting floor area per locomotive under repairs, and about fifteen per cent. more machine shop area than the longitudinal shop. These figures are based on, and confirmed by, a comparison of ten well-known shops; five of each type.

(2) The longitudinal shop has greater flexibility as the number of engines under repairs can be varied according to their size and the spacing required, while in a transverse shop, the pits, drop tables or cranes, etc., cannot be lengthened out to fit larger power at a reasonable cost. For this reason many transverse shops have been entirely outgrown by the large modern power, and, if the articulated type of locomotives come into general use, most of the modern transverse shops will very soon be outgrown in the same manner. This is not true to the same extent of old longitudinal shops, nor is it at all probable with any of the recent shops of this type.

(3) The cost per square foot of area averages somewhat less for longitudinal than for transverse shops on account of the design of the building. The transverse shop generally requires large double doors for every pit, and the cost of the pits themselves is greater, besides some other less expensive features in favor of the longitudinal shops.

(4) Advocates of both types of shop claim that their preferred

arrangement best facilitates the supervision of the locomotive repairs, but I believe that whatever difference there is in this respect is in favor of the longitudinal shop, provided the organizations are equally good in each case. With either type of shop, a foreman or master mechanic cannot personally supervise the work from his office, but must circulate around among the locomotives and make frequent personal inspections of the work. As a rule, I believe that a gang foreman can personally supervise the work on a larger number of locomotives in a longitudinal shop than is possible in a transverse shop. This opinion is based on considerable experience with both types of shops, which leads me to claim that the longitudinal shop is the best for supervision.

(5) With very few exceptions, the output of locomotives per month is greater for longitudinal than for transverse shops. A committee on railroad shops reported to the American Master Mechanics' Association, 1905, giving the monthly output on a ten-hour day basis, as follows:

Eight longitudinal shops, engines per pit..... 1.61
Eight transverse shops, engines per pit..... 1.27

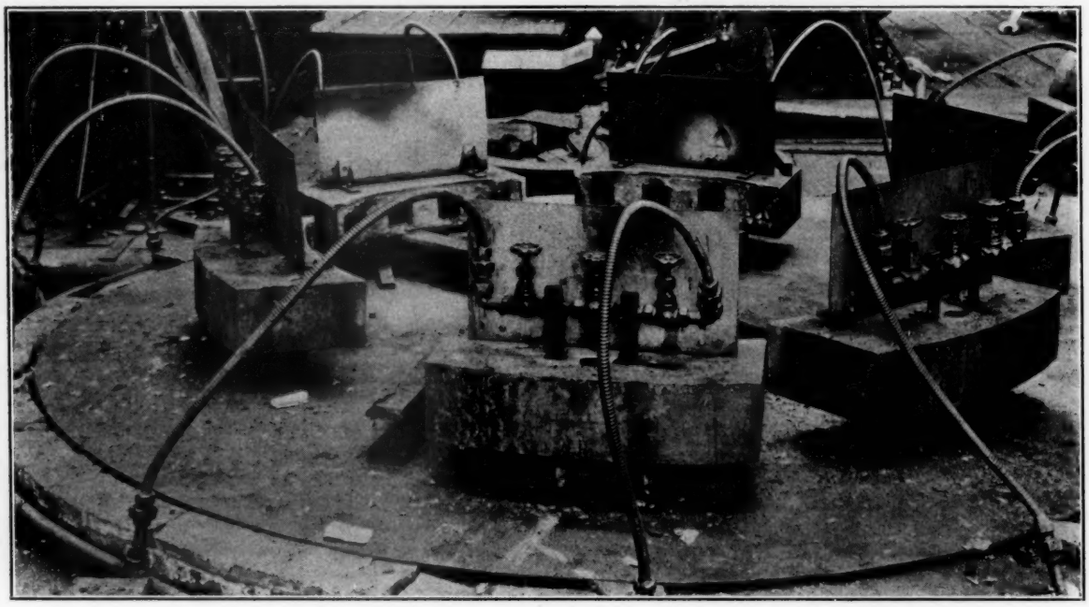
This shows the output of the longitudinal shops about twenty-five per cent. greater than that of the transverse shops, and these results are confirmed by my observations of other shops than those covered by the committee's report.

I might also mention the transfer table generally used with the transverse shops and some other features of less importance, but believe that the arguments above presented will be difficult to offset and quite sufficient to warrant my preference for the longitudinal type of locomotive repair shop.—*M. K. Barnum before the Canadian Railway Club.*

TIRE HEATER.

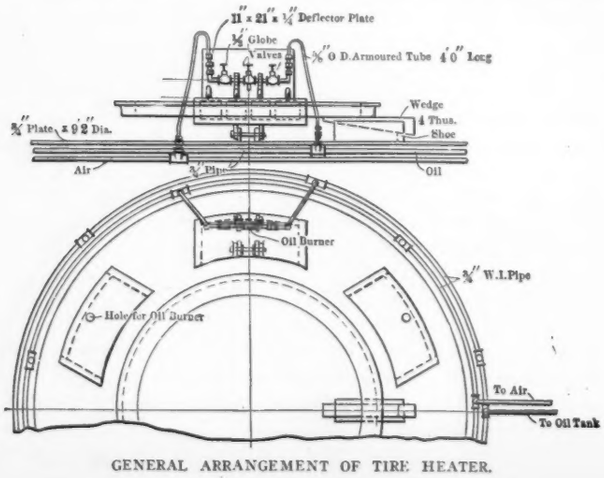
CANADIAN PACIFIC RAILWAY.

The Canadian Pacific Railway has recently introduced a new type of tire heater at its Angus works, which has been found to be far more efficient than the former method of using gasoline and perforated rings of pipe, which slip over the tires.



CRUDE OIL TIRE HEATER AT THE ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

The new heater uses crude oil and consists of six small portable furnaces which are placed on a cast iron plate, as shown in the illustrations. These furnaces consist of cast iron boxes, each supported on four cast iron wheels 3½ in. in diameter. The inside of the box is lined with fire brick 1½ in. thick. A deflector plate is attached to the top of each furnace. The crude oil and compressed air are conducted from the ¾-in. pipes, which surround the base of the device, to the burners through ⅝-in. armored tubes, as shown. It is possible to adjust these portable furnaces so as to produce perfect combustion and to direct the flame on the tire to the best advantage, heating it up much more quickly than by the former methods. A jib crane extends over the heater and the center is lowered into the tire when it has been heated sufficiently. Two of these heaters have been placed in commission and are giving splendid results. We are indebted for information to A. W. Horsey, mechanical engineer.



GENERAL ARRANGEMENT OF TIRE HEATER.

THE FASTEST MOTOR BOAT.—On August 4, the motor boat "Dixie II." made a series of four trial runs over the measured course of the New York Yacht Club in Hempstead Harbor, L. I., which is 1.1 nautical miles long. The boat ran twice with the tide and twice against it. Its average for the four trials was at the rate of 35.74 statute miles an hour, which is the fastest time ever made by a motor boat on officially timed tests, either in this country or abroad. The "Dixie II.," which won the international motor boat race at Huntington, on August 4, was designed by Clinton H. Crane, with engines by Crane & Whitman. It has a single propeller, driven by an eight-cylinder gasoline engine, and can make a trifle more than 800 revolutions per minute, with horse-power of slightly over 200.—*Railroad Age Gazette.*

THE FUTURE OF THE APPRENTICE.

By R. I. GRAVES.

Editor's Note: This paper was written by one of the apprentices of the Chicago & Northwestern Railway. The circumstances under which it was prepared may best be presented by quoting from the remarks of H. T. Bentley, assistant superintendent motive power and machinery of that road, in speaking on the apprenticeship question at the recent meeting of the Master Mechanics' Association:

"Unfortunately we have not such a good scheme of teaching the apprentices on the Chicago & Northwestern as is set forth by the committee; but with 45 apprentices we have two apprentice instructors who follow the young men up and give them every opportunity of becoming proficient in the work they are undertaking, and I think it has had a good effect. We give a certificate or diploma as soon as the young man is out of his time which shows where he served his time and what course he has gone through. About 12 months ago the apprentices themselves organized an apprentice club; they have held 14 meetings and the average attendance at these meetings was 22. To show the scope of the papers and discussions I will name a few of them. The first was, 'The Future of the Apprentice,' and it was one of the best written papers I ever came across. Others were 'The D Slide Valve,' 'Stephenson Link Motion,' 'Valve Setting,' 'The Air Brake,' 'Injectors,' 'Lubricators,' and 'Theory of Combustion.' All the 45 are members of the apprentice club and the officials endeavor to encourage the young men by their presence and to help them by furnishing information they are not able to obtain in any other way."

The future of an apprentice depends upon himself. Whether the future is to be bright and successful, or whether it is to be a dull, common-place existence and a failure, is for each of us to determine. In every case it is up to the man. In this age of hustle and progress, where momentous undertakings and large responsibilities are everywhere in evidence, and where men are constantly departing from the arena of activities because of ill health, old age, and other very good reasons, there comes a cry for trained men, competent men, and reliable men. This "cry" is a demand for men who know their business, for men who are specialists in their line, for men who have been through the mill of practical experience, and who thoroughly understand the work they are called upon to superintend.

To answer this "cry," and to provide for the time when the present officials shall have retired from service, there has been instituted in the shops the apprentice system. We all know what this system is, but do we all realize what it means? We know that when our time is served that we are ranked as machinists and that we are entitled to machinists' wages, but is that all? Is our trade to be the end of our ambition, and are we always to be machinists?

To this point the sailing is quite clear, but as to the future, from here the course seems to be somewhat hazy and uncertain. It is plain that the apprentice becomes a machinist; that when the preliminary training is completed, the young man is well grounded in the fundamentals, that he can do a job on this machine, or that machine, and that he understands mechanical work. It is at this stage that many men stop. They become accustomed to a certain line of work, such as running a drill press, working on rods or a dozen other jobs, and they are content to remain machinists. But there are some men who are not satisfied to remain as machinists, and they refuse to remain stationary. They study, they work faithfully, and in time become foremen, then they go on to master mechanic, and so on they climb to the top.

Now, the men at the top do not want you to be a machinist all your life. They did not give you the opportunity of learning the trade that you might earn good wages and have easy hours. They want you to become good workmen; to do your work well; they want men whose work they can depend upon, and they hope that out of the many apprentices there will be some who will excel, who will develop qualities that will fit them for future officers. They know that all human beings are not the same; that many are shiftless and indifferent, while others are industrious and interested in their work. Of this latter class, they have figured to choose men to fill positions that are being vacated from time to time. The company needs a foreman to-day and a master mechanic to-morrow, and to supply its need, it looks first to its own men. A good man is wanted; he is in demand, and if you are the right man, you will get the position. Thus, you see, the object of the apprentice system. It is a necessity for the future welfare of the company, and being a necessity, it makes the future bright for every apprentice.

The future is indeed bright and promising for the apprentice; there are more chances for him to succeed to-day than ever before. Take a glance at the big men in the railway world and examine their careers. You will find that their records began at the bottom, and that they fought their way on and upward. You will see that the position they hold to-day is the result of hard and faithful application to work and duty.

Let me quote you a few words that Mr. George A. Post, president of the Standard Coupler Company, said about some of the many men who have come up from the ranks: "That masterful personality, Deems, looks now as though he always wielded a scepter, but he didn't. It was not long ago that he wore a 'jumper,' looking after a roundhouse out West. But inside that 'jumper' was a natural-born jumper, and he jumped and he landed, too.

"Facing the blizzards of the Northwest, as he trod the icy roofs of the freight cars in winter, there was once a broad-shouldered, sturdy brakeman, named Underwood. He is not a brakeman now; he's president of the Erie.

"Throwing wood on a locomotive tender and working as a section hand, are both mighty good exercise, but there must be something besides muscle about a young fellow who began his career by doing these things, and who fought his way up to be second in command of the New York Central Lines. Brown accomplished that.

"Outfitted with an ordinary common school education, plus horse sense, pluck and an extra ladle full of gray matter, Truesdale, of the Lackawanna, has winged his flight from a hard-bottomed chair as a clerk to the sumptuous quarters of a railway president."

And there are many, many other cases that might be cited, showing what grit and determination can accomplish. I have quoted these incidences of success that we may see what has been done, and to show us what we have to strive for. If such men have come from the shops, and from the office in the past, they are certainly going to continue to come from these places in the present and in the future.

There are many prizes to be had for the working and the future is full of rewards for the apprentice, if he is the right man. One man has said that success is inevitable to those who boost themselves by their own boosting strength of will and accumulated knowledge. The fellows who go into the shop day after day, wishing that their time was served, wishing that they were drawing machinists' wages, and trying to do as little work as possible, are not going to amount to much. But there are other fellows who are different, and to quote from Mr. Post again: "They have sand, and are not afraid of doing a big day's work; they are not afraid they will do more than some other fellow who gets the same or more pay. They keep their eyes and ears open. They seek instead of shirk responsibility; they look upon their employer as their friend, and not as an enemy." These are the fellows who make good machinists and good officers. To them the future holds many rewards. Mr. Angus Sinclair has said: "A good hand at any occupation, no matter how humble it may be, recommends himself for advancement. The good mechanic, the good car repairer, the skilful foreman, the first-class engineer; the quick, accurate telegraph operator; the pushing, clear-headed track workman; the flagman who protects his train, and the machinist who does his work well, are the men who will be officials a generation hence."

In every new subject that seems uncertain and difficult to us,

there is nothing that makes it more clear, more real and more understandable than illustrations. Oftentimes when we have a job to do that is unfamiliar to us, we look around for something similar to it. If we can find a problem that was done like ours, then, by comparison, we can often do ours more easily. And so in this subject, "The Future of the Apprentice," if we look at the lives of officials, and examine their records, and see how they began their careers, and how they reached their present positions, we can get a better idea of how to accomplish our purpose.

In the Biographical Dictionary of Railway Officials, we find hundreds of men whose lives should serve as thrilling inspirations to the ambitious apprentice, and if, at any time, you feel blue and your ambition lacks enthusiasm, I would suggest that you get hold of this book and read what other railroad men have done. Here is one case which is briefly described: "Entered service of ——— R. R. as office boy, apprentice, machinist, worked in drawing office, chief draftsman, mechanical engineer, shop foreman, master mechanic, division superintendent, general superintendent, general manager, president."

Before concluding, there is one subject that I want to say a few words about, which, to my mind, is a most important essential for the *future of the apprentice.* Too much stress cannot be placed upon the education for a successful career. Education, fellows, is accumulated knowledge, a collection of facts. We cannot rise without knowledge, and definite knowledge gotten by experience is a necessity. If our collection of facts is small, we must increase it, and there are many ways to do this. There's the evening school, the correspondence school, the libraries, and our fellow workmen. And then, as a step, there is this society. As our constitution says, it is for the purpose of scientific investigation along railway lines. These bi-monthly meetings afford a means for study of the subject to be presented, an opportunity to express ourselves on our feet, to discuss the question, to exchange ideas for others, to correct ourselves if in the wrong, and to help the other fellow.

In concluding, allow me to say that diligent application, persistent plugging, a ceaseless hunt for knowledge, and straight living with grit and a big bump of common sense, will do wonders to brighten the *future of the apprentice.*

J. J. Hill's Rule for Success.—My rule for success is untiring application, loyalty to one's employer, which is loyalty to one's self, the "doing the best you can" in every task that faces you; practically, initiative and industry. I am not one, either, who does not believe in a college education for a young man. No man is injured by knowing too much, so long as he knows how to apply that knowledge in a practical way. I am not, however, defending the "intelligent theorist" who is too lazy or too visionary to push his ideas to practicality. But there is not a branch of modern business which does not need scientific knowledge. Why, railroading to-day is a science. So, sooner or later, all knowledge comes into play. But the workingman who does not hold a college degree has, if he has properly applied himself, a practical education that frequently enables him to advance all the faster. Above everything else, however, a man's determination, or his lack of it, to apply what he knows in his way may mean to him just the difference between ultimate success and failure. He need not worry about the opportunities. They are more immeasurably numerous than ever before in our history. And don't forget that opportunities for the man in the ranks, no matter how humble his position nor how poor his circumstances, are greater to-day than ever before.—*From an interview with a reporter of the New York Herald.*

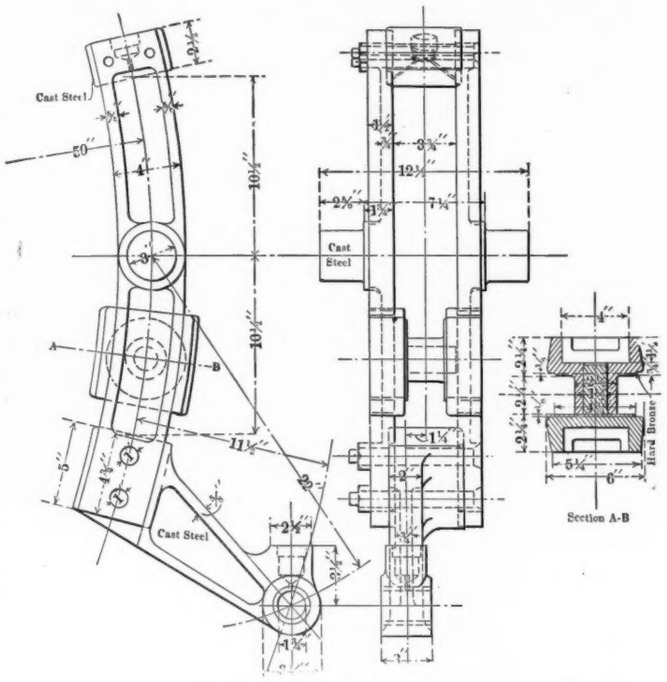
Panama Canal Excavation.—The total excavation for July was 3,168,640 cu. yds., against 3,056,976 cu. yds. for June, 2,703,923 cu. yds. for May and 1,077,498 cu. yds. for July a year ago. The average daily output for July, 1908, was 121,494 cu. yds., against 41,442 cu. yds. in July, 1907. In July of this year 1,874,173 cu. yds. of material were removed by steam shovels.

A SIMPLE DESIGN OF LINK AND LINK BLOCK.

The accompanying illustration shows a link and link block forming part of a Walschaert valve gear which was designed and recently applied by the Baldwin Locomotive Works to a Mikado type locomotive for the Kentucky and Tennessee Railway.

The link proper is built of four steel castings—two side plates and two filling pieces. Each side plate is cast in one piece with its corresponding trunnion and the lower filling piece is provided with an arm to which the eccentric rod is attached.

The link block is of hard bronze and is made in two pieces. It is guided in the link by projecting lips, which bear against



LINK AND LINK BLOCK FOR WALSCHAERT VALVE GEAR.

the edges of the side plates. The two sections of the block are held together by means of lugs, which are circular in section and fit one within the other. The larger and outside lug thus constitutes a pin for connection to the radius rod. The latter passes between the side plates and may be suspended either in front of or behind the link as preferred.

This link is supported by a bearing which is made in one piece and is assembled, with the radius rod, in this bearing. This makes a very simple arrangement with a minimum number of parts and amount of fitting. Application has been made for patents covering the special features of this link and block.

SUPERHEATING.

The following recommendations, as to the operation and maintenance of superheater engines, were made by the committee on superheating in its report at the recent meeting of The Traveling Engineers' Association.

In the operation of the superheaters the following suggestions should be carried out:

(a) When working steam, open throttle valve fully and regulate with cut-off.

(b) Keep water level in boiler as low as in saturated steam engines.

(c) Ascertain that dampers (where equipped) in smoke box are working properly, also that the small steam cylinder actuating these dampers is not leaking through stuffing box.

(d) Be sure that oil is carried from lubricator to each end of valve and also to cylinder.

(e) Any leaky steam joints at cylinders or valves should be tightened, and if connections or joints of superheater proper should be found leaking, report at once at end of run.

The work of maintaining and taking care of the superheater in the roundhouse is enumerated in the following:

(a) Keep all steam joints and connections of superheater, as well as cylinders and valves, tight.

(b) Piston and valve rings should have a close fit to cylinder walls and valve-bushings respectively.

(c) Clean or blow out large smoke flues whenever necessary. The more attention paid to this work, the more economy will be attained with the engine.

(d) The ends of the large smoke flues which originally were screwed in the fire-box flue sheet and have given trouble by leaking, should be rolled and expanded.

(e) In renewing tubes of superheater elements, use only seamless cold drawn steel tubing. See that they are put in correct length, otherwise, due to contraction and expansion, the connections in the U-bent castings will work loose and leak or tubes will split.

(f) The ends of the superheater elements nearest to the fire-box are supported by lugs or legs of the U-bent castings. Due to the expansion and contraction of the elements, these lugs ride or chafe the bottom of the large smoke flues. Ascertain if this riding or chafing has weakened the large tube. If so, renew the tube.

(g) Pay attention to the dampers, their lever connections and the small steam cylinder. Pack the latter whenever necessary, as any leakage will be detrimental to operating the dampers. See that all hinges of dampers, also the lever connections, are in good working order.

(h) The lubricator should be tested whenever necessary.

(i) Injectors must be connected with saturated steam. They will not work properly with superheated steam.

ROUNDHOUSE WORK REPORTS.

On page 191 of the May issue a division foreman directed attention to the necessity of improved methods of handling roundhouse work reports.

G. A. Miller, superintendent of motive power and machinery of the Florida East Coast Railway, has sent in the form shown in Fig. 1, which is used on that road. The engineer fills out this form in triplicate; the original copy he sends to the office of the superintendent of motive power and machinery and the duplicate and triplicate copies he gives to the roundhouse foreman. The roundhouse foreman personally assigns the different items of work to the men and keeps the work report on his desk until the work is completed, as it may be necessary for several men to refer to it and sign it. The men sign the triplicate report, which is retained by the roundhouse foreman. The foreman fills in the names of the workmen who perform the different jobs on the duplicate and forwards it to the superintendent of motive power and machinery. The note at the bottom of the duplicate reads as follows: "This copy to roundhouse foreman who will give proper credit to those who did the work, and send it to S. M. P. & M., St. Augustine." The note on the triplicate reads: "This copy for roundhouse foreman's reference and files."

Form 200 500 Sh. 10-06 Record Co. 21077

FLORIDA EAST COAST RAILWAY.

ORIGINAL

.....Fla., ...190....

Report of work to be done on Eng. .....

Arr. on train.....at.....M.; Due to lve. on train.....at.....M.

.....Engr. .....Hostler.

	WORK DONE BY	HRS.

NOTE: Report present work needed without reference to previous reports and each piece of work so that party doing same can sign against it. Send Original to S. M. P. & M., St. Augustine. Duplicate and Triplicate to Round House Man.

FIG. 1.—ENGINE WORK REPORT FORM, FLORIDA EAST COAST RY.

J. S. Sheafe, mechanical inspector of the Illinois Central, has directed attention to the form shown in Fig. 2, which is similar to one that has been used successfully on a western road. The engineer reports the defects, using a line for each item, so as to avoid confusion. The foreman may or may not assign the work, but in any case the workman signs the original work report, which remains upon a clip until the work is finished, or the engine goes out, when it is taken into the office for permanent record and is filed either under the engine number or the date. These reports can be handled many times without becoming illegible and the workmen take pains to keep the sheets in good condition. It is possible for the foreman to keep a close check on the work, if it is understood that the workmen are to sign the report as soon as each job is finished. Each engineer should use a separate sheet to avoid confusion.

THE COMPOUND LOCOMOTIVE.—There is nothing the matter with the compound locomotive; the only trouble with the use of these engines in the United States is that they require a greater attention, a greater detailed supervision of their finer mechanism, than is the case with simple engines which are cheaper to build, perhaps cheaper to maintain (though not on a performance-unit basis) and certainly less efficient in the use of power and in the haulage of loads. —*H. W. Jacobs in The Engineering Magazine.*

T-9-06-200 Bks 100 lvs. Form No. 1443.

——— ——— Railroad Company.

Machinery Department.

REPORT OF WORK REQUIRED ON ENGINES. _____ *Shop.*

Enginemen must carefully inspect their Engines after each trip and report all necessary repairs. They will be held responsible for every defect not reported. No attention will be given to verbal report, or report not signed by Engineer. Employe making repairs will draw a line under each item of work completed, and sign his name opposite report.

DATE	ENGINE NUMBER AND INITIALS	REPAIRS REQUIRED	ENGINEER	REPAIRED BY

FIG. 2.—FORM IN SUCCESSFUL USE ON A WESTERN RAILWAY.

SUPERHEATED STEAM FOR LOCOMOTIVES.*

By Robert Garbe.†

Compounds and Superheating.—The use of highly superheated steam in a simple two-cylinder locomotive in its present state of development gives such a large increase in working capacity that the demands for increased hauling power and speed may in the immediate future be met together with increased economy, without having recourse to four-cylinder compounds, which are both complicated in construction and costly in maintenance. This, in the author's opinion, is one of the most essential advantages of superheated steam working in locomotive practice and has been taken into account in a large number—exceeding 1,000—of these engines in the Prussian State Railway service, all of which are of the simple two-cylinder form, without trailing axles, while the construction of the wet steam four-cylinder compounds has been almost entirely given up on that service. This example has not, however, been followed to the extent that, in the interest of simplicity, economy and safety in working, is to be desired. Many railway administrations for want of experience with superheated steam adhere to the costly and complicated four-cylinder wet-steam class, while others taking the first steps in superheating restrict it to moderate superheating in combination with the compound cylinder arrangement.

Both compound working with wet steam and high superheating have the same object, viz., the diminution or prevention of condensation losses in the cylinders, which in plain wet steam engines amounts to 35 per cent. and upwards. By compounding this may be reduced to 20 or 25 per cent., while with highly superheated steam at 600 or 660 degrees F. they may be entirely prevented, even in the simple two-cylinder locomotive. The question of initial superheat of about 100 degrees F. for preventing a deposit of water in the high pressure cylinder has been shown by Schmidt to be sufficient if the cut-off is not reduced below 50 per cent. of the stroke. This, however, entirely exhausts the extra heat so that the subsequent expansion in the low pressure cylinder is conducted under disadvantageous conditions. A notable steam saving by superheated compound as compared with superheated simple working can only be realized by avoiding low pressure cylinder condensation also, but this involves superheating to 570 degrees, and then it makes no difference whether the steam is expanded in one or two cylinders. With this degree of superheat, heavy steam admissions of 60 to 70 per cent. of the stroke, which are often required on grades, will raise the average temperature of the high pressure cylinder to such an extent as to cause lubrication troubles or even endanger its stability.

But even when highly superheated steam could be used on a compound locomotive the fuel economy as compared with a highly superheated simple engine would only be small and is not in any reasonable relation to the increased difficulties of construction, cost and maintenance. Above all, no notable increase in working capacity can be expected from it, as the most advantageous degree of steam admission is a fixed and invariable quantity for any particular average working demand and temperature. If this point is exceeded steam is wasted, and if it is reduced cylinder condensation results and the economy is reduced. Taking also into consideration the starting difficulties, the increased charge for boiler repairs, due to the objectionable high initial pressure of 200 pounds or more, and the increased capital and maintenance cost, its adoption can in no case be recommended merely on the ground of small fuel saving, which is only realizable under specially favorable conditions and involves the abandonment of the much greater advantages of the simple two-cylinder arrangement. The question of the number of cylinders is not included in the above considerations. The advantages of three and four cylinders on a locomotive are principally to be sought in the diminution of the so-called disturbing movements.

An undoubted advantage of the four-cylinder engine is to be found in the four crank arrangement, which by lowering the strain on the main axle bearings reduces the wear on the journals. Against this it must be borne in mind that the use of inside crank axles limits the possible length of the main journals.

When it is considered that the so-called disturbing motions give rise to close recurring and non-culminative powers, and that the equalizing of the reciprocating masses in two-cylinder engines must not be pushed too far, to avoid excessive variation in the axle load during the revolution of the wheel, and further that two crank engines run continuously and safely at speeds up to 75 miles an hour, the assumption appears to be justified that the use of more than two cylinders at the highest required speeds is not a question of greater safety, but only one of reducing wear on the bearing parts and smother running of the axle journals in their bearings, and not of the engine itself, or of quiet running on the rails so far as this depends upon the causes mentioned. It is a fact well established by practical trials that properly constructed two-cylinder engines in good working order run perfectly satisfactory at all speeds practically attainable. Further help along this direction has been obtained in the new superheated steam two-cylinder engines of the Prussian State Lines by the removal, on the author's advice, of the counterbalance on the driving wheels for the reciprocating parts and the adoption of a rigid tender coupling. In this way one of the much vaunted advantages of the four-cylinder engine, the repression of the vertical centrifugal force is obtained in a simple manner. The effect of the short connecting rod of the four-cylinder engine in increasing the vertical pressure on the cross-head, which acts alternately on the frame and the driving axles, is equally detrimental with the varying centrifugal forces of the counterbalance, and in this respect the simple two-cylinder engine with its long driving wheel base is decidedly superior to the multiple cylinder form.

This being so, the adoption in the plain two-cylinder engine of all available methods for preventing premature wear of the bearings is essentially to be recommended upon technical and economical grounds. These movements may be best attained by attention to the following simple conditions in combination with a sufficiently large rigid wheel base: Best materials for all reciprocating parts, so that they may be made as light as possible; enlargement of the journals and crank pins and use of three part axle bearings; proper stiffening of the frames; proper proportions of compression; improvement of the engine and tender couplings, by the use of a strong cross spring and reduction of the working pressure to 150 pounds.

Should the demand rise upon specially constructed lines for speeds of 70 miles an hour, on an average, with a maximum of 90 miles per hour, the necessity for the four-cylinder engine might be felt. This, however, could better be met by retaining the four-coupled eight-wheel form in combination with four equal-sized high-pressure cylinders and a long wheel base.

CONSTRUCTIVE DETAILS.

For the use of highly superheated steam it is essential that all parts of the engine with which it is brought in contact, such as cylinders, pistons, stuffing boxes, slide valves, etc., shall be constructed in such a manner as to meet the special properties of that medium. Although as in the case of other novelties, particularly in locomotive building, this was attended with considerable difficulty at first, such difficulty has now been overcome.

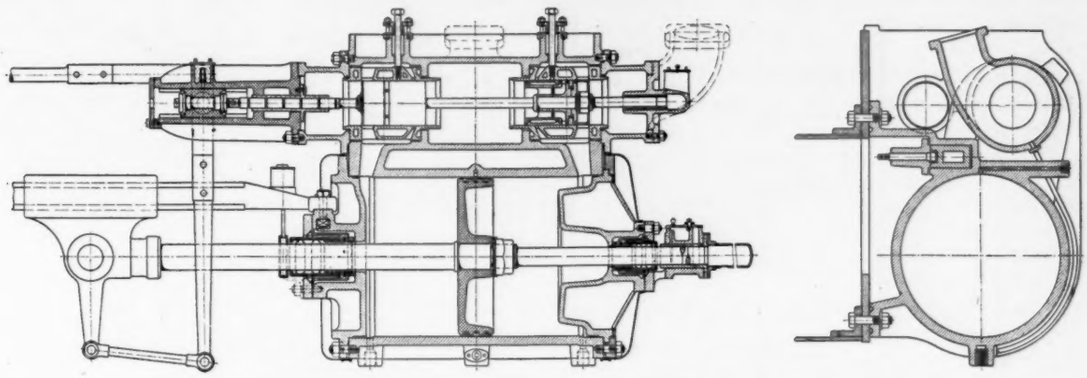
Cylinders and Pistons.—In the design of the hot steam cylinder particular care must be taken to avoid all sudden alterations of section likely to cause irregular expansion of the structure by heat, and the body of the cylindrical slide valve chest must be kept entirely separate from the cylinder in order that the latter may not be more highly heated in the parts nearest to the admission ports than in those nearest the exhaust ports.

After a long and troublesome series of experiments with a view of obtaining a tight working piston as nearly frictionless as possible, a simple modification of the well-known Swedish piston has been obtained (shown in Fig. 1), and has given extremely satisfactory results.

This success is due to the fact that the three light packing rings bear none of the weight of the body of the piston, their

*Abstract of a series of articles published in the *Engineer* (London). Continued from page 98, March issue of this journal.

† Privy Councilor, Prussian State Railways.



GENERAL ARRANGEMENT OF CYLINDERS AND VALVES FOR SUPERHEATED STEAM.

function being merely to form a steam-tight joint by their slight elasticity and the small pressure acting behind them jointly. Three rings are used in order that the middle one may never be subjected to back pressure. Each of the rings is perforated radially by six holes .118 in. in diameter, spaced at equal distances apart, and opening into a shallow groove turned into the outer surface, giving a series of passages from the front to the back of the ring. When, therefore, at the change of stroke the first or third ring is driven by compression out of contact with the cylinder, steam makes its way behind it through the small exposed passage and

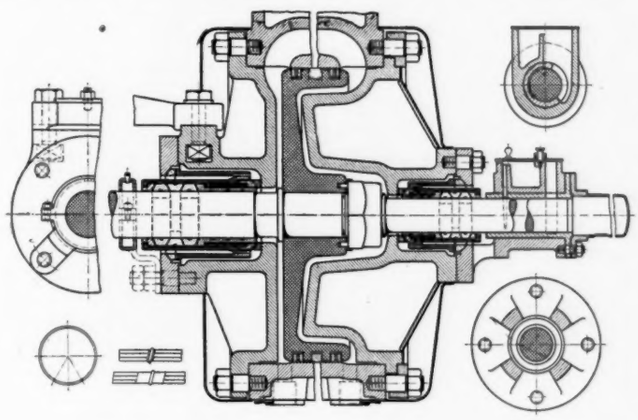


FIG. 1.—PISTON USED WITH SUPERHEATED STEAM.

presses it back, a too sudden restoration of the contact being prevented by the reflex action of part of the steam flowing back into the groove and cushioning the blow. Furthermore, a small amount of steam finds its way between the ends of the second and third rings and their seats on the piston, relieving the pressure sufficiently to insure merely a light contact with the side of the cylinder.

The piston body, cast of the highest quality of steel, is made as light as possible. Both the outer and inner edges of the ring seats are rounded, the former somewhat more than the latter, to facilitate distribution of the lubricating oil. The diameter is made about .118 in. less than that of the cylinder to prevent cutting during withdrawal, and also when, from wear in the stuffing-boxes, the piston is no longer perfectly central. Neither the body of the piston, the packing rings, nor the stuffing-boxes must at any time carry any part of the weight of the piston. The piston rod has a special guide in front, and is carried behind by the crosshead, so that the piston is kept nearly floating in the cylinder.

Stuffing-Boxes.—With hot steam the use of metallic packing with free lateral motion for the piston-rod is essential. A packing, which has been quite successful, is shown in detail in Fig. 1.

If the piston is kept centered as closely as possible by proper packing of the crosshead slipper, and timely renewal of the forward guide-bars, which measures are absolutely necessary for proper and regular working, the stuffing-box packings will run for years with extremely small wear in any of their parts.

Piston Valves.—In all hot steam engines piston valves should be used, the steam being admitted from the inside, giving a naturally balanced construction. This does away with the necessity of stuffing-boxes in the valve chamber, as the outer surfaces of the valve are only under the low pressure of the exhaust steam, which is absorbed when a sufficiently long channel or labyrinth packing is used. These valves are constructed in two principal forms.

1. Piston valves with solid rings, double admission and steam jacketed valve chest.

2. Piston valves with partly counterbalanced spring rings and slide cover under steam pressure.

The first of these forms (shown in Fig. 2) is that principally used by the Prussian State Lines, while the second is favored by most of the other railways using superheated steam.

In the first valve the rings are undivided, and are closely fitted by grinding to gauge, being, as is the slide rod, kept tight by labyrinth packing grooves alone. With this arrangement the valve can be readily moved by hand, whatever may be the steam pressure in the valve chamber, the resistance being so small that all the motion parts may be made considerably lighter than formerly, while their durability has been notably increased.

As at first constructed, however, difficulties were experienced from irregular expansion between seat and valve, and it became necessary to keep the diameter of the valve as small as possible. This has been done by using double admission ports, and the valve chest has been jacketed and heated with the highest temperature steam. These modifications have made it possible to adopt a single size, 6 in. in diameter, of valve for the whole of the hot-steam locomotives of the Prussian State lines, even in the express engines with 23 in. cylinders. That these small valves run at the highest speeds without excessive throttling is to be attributed to the extreme mobility of the steam when highly

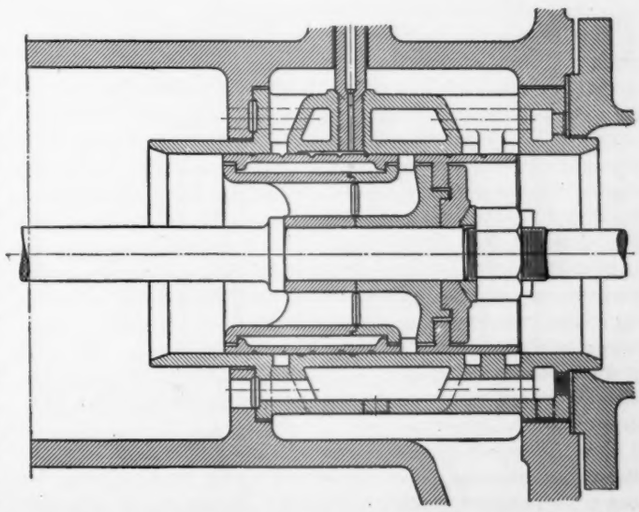


FIG. 2.—PISTON VALVE USED ON PRUSSIAN STATE LINES WITH SUPERHEATED STEAM.

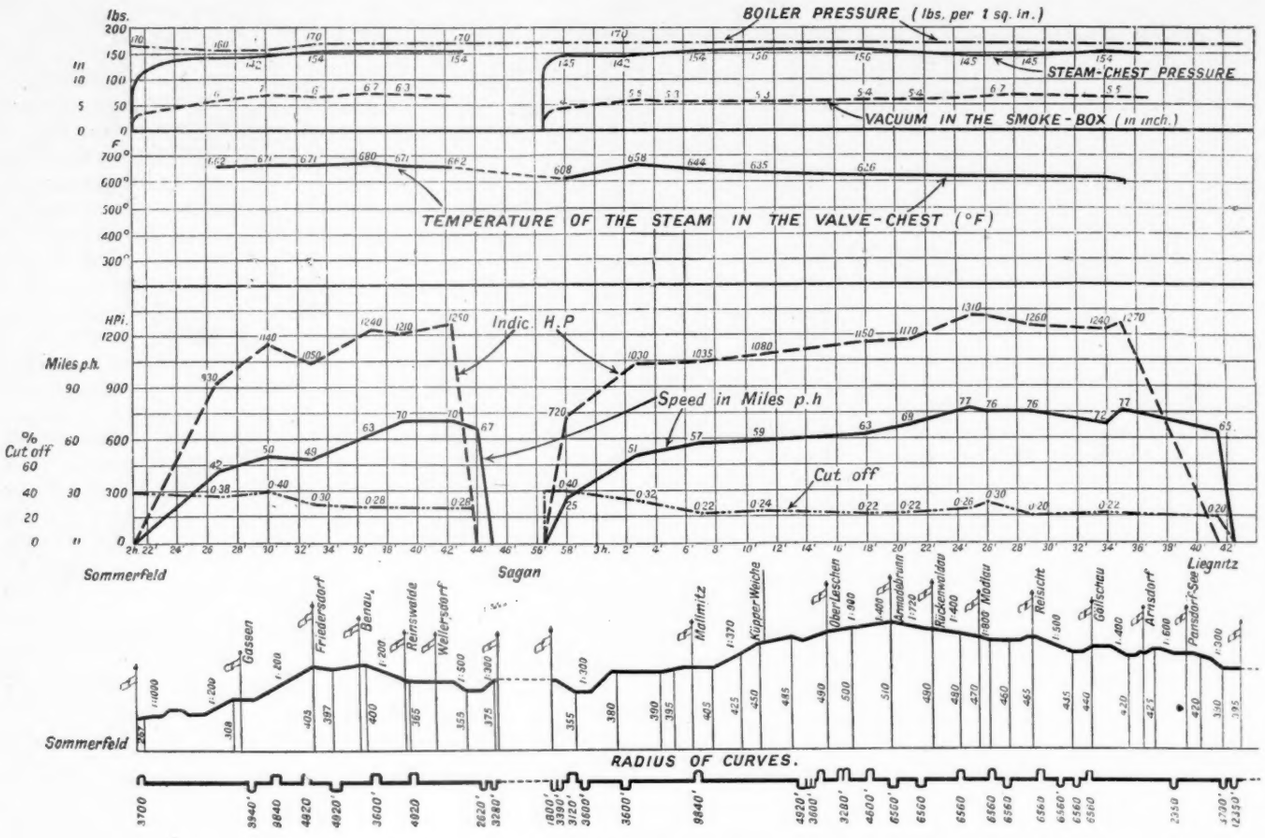


FIG. 4.—TRIAL RUN WITH A (4-4-0) SUPERHEATED STEAM LOCOMOTIVE WITH SCHMIDT SMOKE-TUBE SUPERHEATER, ON MARCH 31ST, 1906, FROM SOMMERFELD TO LIEGNITZ (67 MILES—PRUSSIAN STATE RAILWAYS).

Weight of carriages	301.6 tons	Heating surface, fire-box	132.5 sq. ft.
Weight of train	406.4 tons	" " tubes	1292.8 sq. ft.
Type of engine	4—4—0	" " superheater	341.2 sq. ft.
Diameter of cylinders	21.65 in.	" " total	1766.5 sq. ft.
Stroke	24.8 in.	Weight on driving-wheels	31.5 tons
Diameter of driving wheels	82.67 in.	Weight of engine in working order	56.7 tons
Boiler pressure	170 lb. per sq. in.	Weight of tender in working order	78.1 tons
Grate area	24.2 sq. ft.	Coal	5 tons
		Water	4730 Brit. gals.

superheated, and the advantages arising from the adoption of a single standard size of valve for all classes of engines will be apparent without further comment.

With regard to the objection raised by many authorities to valves of the construction described above on the ground of leakage, it must be remarked that the loss of steam measured when at rest is no measure of that taking place when running. These long close rings necessarily allow a considerable amount of steam to pass as a condition of maintaining their frictionless floating character when at rest, but such leakage decreases rapidly with increase of speed when in motion. A thin film of oil works into the clearance space between the valve casing, forming a perfectly satisfactory packing. Rings that have been long in use show no perceptible wear, but, on the contrary, their diameter may be slightly increased by a thin, compact deposit from the carbonizing of the lubricating oil on such parts as allow of its formation. This fact has been frequently observed. Finally, it may be remarked that small leakages into the cylinder during the admission and expansion periods are not prejudicial, and the loss during compression can only be insignificant. At any rate, the small power sacrificed from this cause bears no relation to the much greater amount required to work large flat valves or heavy unbalanced piston valves, to say nothing of the much greater wear and tear of the latter.

Piston slide valves have the defect that, unlike flat slides, the pressure on the seat is not diminished during running when the steam compression becomes too high. To avoid the injurious shocks in the rods and motion due to this cause, hot steam locomotives are provided with the contrivance shown in Fig. 3. This is a by-pass tube 2.35 in. bore, connecting the two ends of the cylinder, having a cock in the center. When the steam throttle is closed this is opened, and the pressure on both sides is equalized. This cock is steam-heated, and to prevent it becoming fixed on its seat, it is only loosely fitted, the steam pressure from either side keeping it tight in its place during running. The valve stem is connected by a grooved and dovetailed slide, and the grooves turned in the outer guide form a labyrinth packing, and so dispense with a stuffing-box. This is worked by hand with

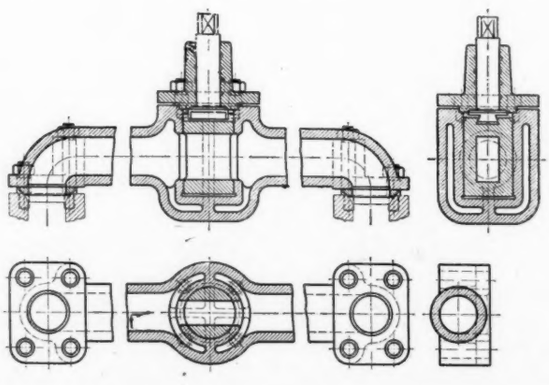


FIG. 3.—BY-PASS TUBE CONNECTING THE TWO ENDS OF CYLINDERS.

a key on the square end of the stem, and has taken the place of a former self-acting arrangement, which was not found to work

satisfactorily. The driver has to open the passage immediately on closing the throttle and must close it again before re-admitting steam to the engine.

Lubrication.—A matter of primary importance in the use of hot steam in locomotives is the provision of appropriate lubrication for the parts working under steam—the piston and slide valves—which, both in regard to material and arrangement, call for special modification in details.

The high temperature makes it necessary to use only pure mineral oils of particularly high flash points, which must be supplied to the rubbing surfaces in determinate quantity according to the speed, *i. e.*, the revolutions of the driving wheels. It must be prevented from becoming mixed with water, or heated and decomposed by steam, both of which effects are more or less likely to occur with drop or sight feed lubricators. The access of condensed water to the surfaces to be lubricated is injurious to working parts, and is a cause of waste by the steam carrying finely divided oil to parts not requiring to be greased.

A further objection to drop lubricators in hot steam work is to be found in their inflexibility, the oil being distributed by a continuous flow from one or other end of the supply pipe in the direction of lower pressures, irrespective of the requirements of the surfaces. Now for successful lubrication, it is essential that it shall be possible to meet all variations of pressures on the rubbing surfaces by varying the supply of oil as necessities may arise. These considerations have led to the adoption of pressure lubricators. As the oil has to be supplied to three places on either side of the engine, two to the valves and one to the cylinder, the oil presses must be fitted with six cylinders, and the communication pipes must be kept constantly filled and under pressure, with appropriate return valves at the distributing points. The return valves or oil savers are important features in the arrangement, preventing irregularity of flow from changes of pressure in the places to be lubricated, and the waste of the oil from the supply pipes when the engine is standing or running without steaming for any length of time.

Special Equipment Details.—In addition to the items described above, certain special fittings are required for the hot steam locomotive. These include a pyrometer and a pressure gauge for determining the superheat and pressure at the valve chest, a smoke-box vacuum gauge, and a hand rod for the pressure equalizer, placed near the hand wheel of the valve gear. The handle for regulating the superheater flap valve is placed on the left-hand side of the fire-box.

TRIALS.

From the large amount of accumulated experience obtained on trial trips and in ordinary working with hot steam locomotives, only a few important points will be selected.

From the results of working alone it is not, however, easy to form a correct opinion as to the actual economy in consumption, as in many cases both handling and maintenance of hot steam locomotives leaves much to be desired. The much more favorable results obtained on trial trips are to be regarded as ideal maxima obtainable by the method, and that these are not realized in continuous working is to be attributed to the circumstance that the size of the trains and the running times are arranged to meet the conditions suited to the best and most economical working of the ordinary locomotives, and not those suited to the much higher capacity of superheat locomotives. Notwithstanding these drawbacks, the average saving of coal as derived from practical working with superheated steam is from 25 to 30 per cent. of the consumption of simple and 15 to 20 of compound engines using saturated steam.

Increased Working Capacity.—The working results of a superheated steam locomotive on the Prussian State lines is represented graphically in Fig. 4.

The brilliant results are so clearly expressed in the figures that further explanations will be superfluous. Similar results have never been obtained with saturated steam in engines of the same weight and number of axles, and when it is remembered that they have been accompanied by important savings, it can no longer be doubted that the adoption of highly superheated steam in the simple two-cylinder locomotive affords the best means of increasing the power of the locomotive while retaining simplicity of construction.

Construction and Maintenance Cost.—Having thus demonstrated the advantages of the system, the objections made on the ground of greater costliness remain to be considered. The extra cost due to the superheater, and the increased size of some of the working parts, having regard to the necessary advantages already noticed, and the practical abolition of double heading, are comparatively small, and with the unification of the details, and their production on a large scale, are likely to be considerably reduced.

It will be easily understood that during the experimental period many mistakes were made. Every new form brought its own problems with it, and the experience gained with each has been utilized in its successor, so that at present the desired simplicity has been attained, and the accumulated experience as to the durability of the superheater and other parts, and the work required for their maintenance, is uniformly favorable.

As regards the cost of maintenance, the experience with smoke tube superheaters on the Prussian State Lines extends over too short a period to allow of a final estimate being formed, but their excellent behavior in current work, together with the much larger experience of foreign railway companies, justifies the opinion that no difficulties are to be anticipated on this ground.

It is, however, essential that the regulations for tube cleaning shall be rigorously observed, as, if this is not thoroughly done, deposits accumulate in the tube, diminishing the free draft of the heating current, with a necessary lowering of the heating power.

ADVANTAGES OF HAVING CAREFULLY PREPARED SPECIFICATIONS.—When competing manufacturers are furnished with carefully prepared specifications, and if necessary, drawings also, showing exactly what is wanted, they are then able to figure the closest prices they can afford to name without having to make any allowances for uncertainties. When definite specifications or drawings establish a fair and exact basis for comparing the relative merits of bids, manufacturers will ordinarily submit lower prices for material of the quality specified than they would do otherwise. If a manufacturer feels that certain railroad companies will repeatedly purchase from him in large quantities articles of exactly the same kind, and will not change their standards without excellent reason, he will ordinarily quote very low figures hoping thereby to secure such business continuously. By concentrating orders for the same devices or materials with one, or in a few cases with two, well equipped and reliable manufacturers, more uniformity can be secured, and the ordering, inspection and forwarding of shipments are facilitated and accomplished with greater economy. Another great advantage in having intelligent and definite specifications and drawings is that it facilitates a fair inspection, and, when articles are furnished in accordance with definite conditions, there is far less uncertainty as to results that will be obtained by their use.—*W. V. S. Thorne before the New York Railroad Club.*

HANDLING OF COMPANY COAL.—As a rule the office of fuel agent comes under the mechanical department. The fuel agent endeavors to buy coal where he can get the most heat value for the price he pays. This is sometimes worked out mathematically by making coal tests to determine the value of various coals and then distributing them according to price and length of haul without any regard to the car situation, the grade of the road and of the direction in which the volume of business is traveling. A system of coal distribution which might be ideal from the purchasing agent's standpoint might be very uneconomical under certain operating conditions, and if the fuel agent is not broad gauge enough to see into and allow for practical conditions he will probably waste a good deal of money before being checked. He must keep in touch with the car service and operating officials as well as with the coal situation to get best results.—*Dexter C. Buell before the Central Railway Club.*